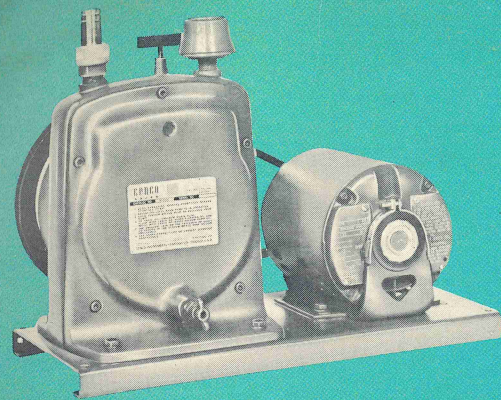


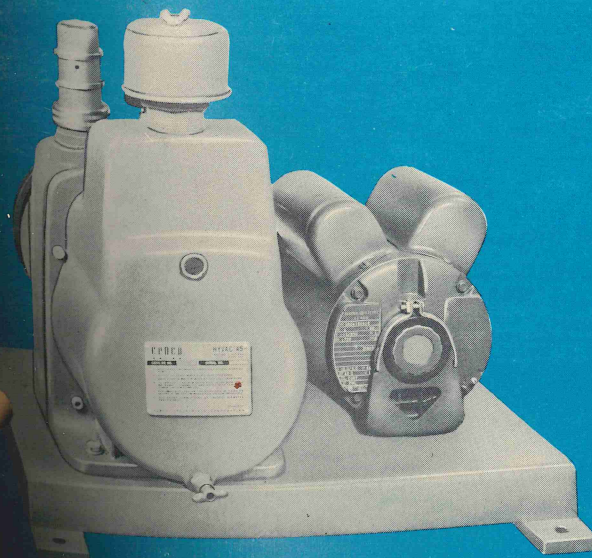




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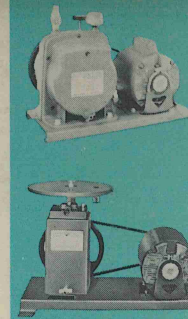


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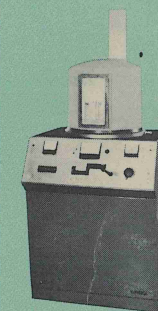
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over 100 models
pages 1-20



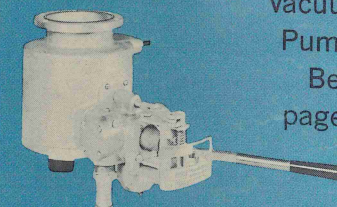
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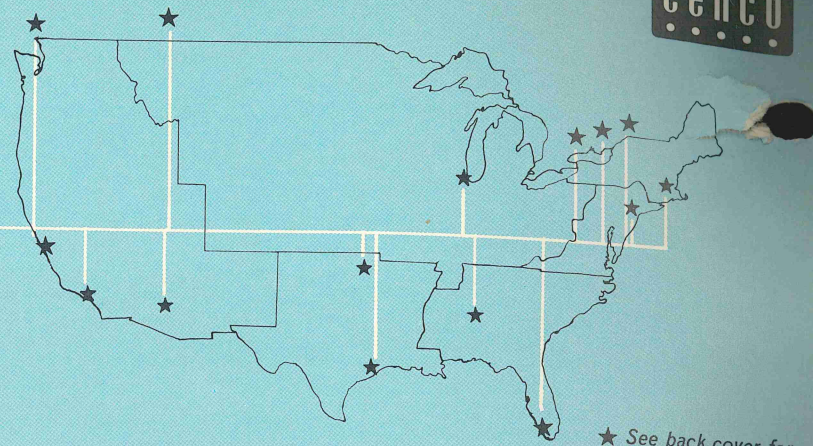


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Traps and Baffles
Tubing and Clamps
pages 50-59

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437 SYSTEM-MATERIAL
VACUUM COMPONENTS

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★ See back cover for
complete listing of Cenco Branches.

GLOSSARY OF VACUUM TERMINOLOGY

This is a partial list of standard terms used in vacuum technology and is adapted from those prepared by the Standards Committee of the American Vacuum Society.

BACK STREAMING The direct flight of vapor molecules by scattering from the hot vapor jet or evaporation from hot nozzle parts in the direction of the mouth or intake port of a vapor pump.

BAKE-OUT The degassing of a vacuum system by heating in an oven during the pumping process.

CONDUCTANCE (Measured value) The physical measure of a system which describes its ability to accommodate the flow of gas, usually measured in liters per second. Specifically, the throughput under steady state conservative conditions divided by the measured difference in pressure between two specified cross sections inside a pumping system. $C = Q/(P_1 - P_2)$

DEGASSING The deliberate removal of gas from a material, usually by application of heat under high vacuum.

DIFFUSION PUMP A vapor pump having boiler pressures less than a few Torr and capable of pumping gas with full efficiency at intake pressures not exceeding about 20 millitorr and discharge pressures (forepressures) not exceeding about 500 millitorr. The pumping action of each vapor jet occurs by the diffusion of gas molecules through the low-density scattered vapor into the denser forward moving core of a freely expanding vapor jet.

FOREPRESSURE The total pressure on the outlet side of a pump measured near the outlet port.

FORE PUMP The pump which produces the necessary fore vacuum for a pump which is incapable of discharging gases at atmospheric pressure. Sometimes called the backing pump.

FREE AIR DISPLACEMENT The volume of air passed per unit time through a mechanical pump when the pressure on the intake and exhaust sides is equal to atmospheric pressure. Also called free air capacity.

GAS BALLAST PUMP A mechanical pump (usually of the rotary type) equipped with an inlet and

valve through which a suitable quantity of atmospheric air or "dry" gas can be admitted into the compression chamber so as to prevent condensation of vapors within the chamber by maintaining the partial pressure of the vapors below the saturation value. Sometimes called a vented-exhaust mechanical pump.

HOLDING PUMP A fore pump used to hold a vapor pump at efficient operating conditions while a roughing pump reduces the system pressure to a point at which the valve between the vapor pump and the system can be opened without stopping the flow of vapor from the nozzles.

IMPEDANCE The reciprocal of the conductance. Also called resistance. $Z = 1/C$.

LEAK RATE The quantity of gas in pressure-volume units at room temperature flowing into the system or through the pump from an external source in unit time.

LIMITING FOREPRESSURE The forepressure which corresponds to an inlet pressure about 0.2 millitorr greater than the inlet pressure corresponding to the normal forepressure for a vapor pump at a given load (or throughput).

MEASURED SPEED (of pump) The leak rate of gas admitted from a flow measuring device divided by the total pressure measured near the mouth (or inlet port) of a pump with a specified gauge mounted in a specified testing head. $Sm = Lm/P$.

MECHANICAL PUMP A pump which moves the gas by the cyclic motion of a system of mechanical parts such as pistons, eccentric rotors, vanes, valves, etc.

MERIT FACTOR The ratio of the speed of exhaust of a mechanical pump for air at one micron to the free air displacement. $Mf = SI/Sf$.

MICRON OF Hg A unit of pressure equal to 1×10^{-3} millimeters of Hg. In modern usage it is being replaced by 1×10^{-3} torr or millitorr.

MICROTORR A unit of pressure equal to 10^{-6} Torr.

MILLIMETER OF Hg and its abbreviation mm of Hg is equal to 1/760 of a standard atmosphere. This term is being replaced by the new international standard unit Torr.

MILLITORR A unit of pressure equal to 10^{-3} Torr.

MOLECULAR FLOW The flow of gas through a duct under conditions such that the mean free path is

greater than the largest dimension of a transverse section of the duct.

OUTGASSING The spontaneous evolution of gas from a material in a vacuum.

ROUGHING PUMP The pump used to reduce the system pressure to the point at which a vapor pump (or other pump requiring a fore vacuum) can take hold and operate efficiently.

SPEED The speed of a pump for a given gas is the ratio of the throughput of that gas to the partial pressure of that gas at a specified point near the mouth (or inlet port) of a pump. $S = Q/P$.

SPEED OF EXHAUST The magnitude of the rate of reduction of pressure in the system multiplied by the volume and divided by the measured pressure.

THROUGHPUT The quantity of gas in pressure-volume units at a specified temperature flowing per unit time across a specified open cross section of a pump or pipe line.

Suggested international standard term to replace the English term millimeter of mercury and its abbreviation mm of Hg. The Torr is defined as 1/760 of a standard atmosphere.

ULTIMATE PRESSURE The limiting pressure approached in the vacuum system.

VACUUM
ROUGH VACUUM: 760 to 1 Torr (Torr range)
FINE VACUUM: 1 to 10^{-3} Torr (millitorr range)

HIGH VACUUM: 10^{-3} to 10^{-6} Torr (microtorr range)

VERY HIGH VACUUM: 10^{-6} to 10^{-9} Torr (nanotorr range)

ULTRA-HIGH VACUUM: 10^{-9} Torr and below

VISCOUS FLOW The flow of gas through a duct under conditions such that the mean free path is very small in comparison with the smallest dimension of a transverse section of the duct.

CONVERSION MULTIPLIERS		
FROM	TO	MULTIPLY
LITERS/SEC	CUBIC FT/MIN	2.12
LITERS/MIN	CUBIC FT/MIN	0.0353
LITERS/SEC	LITERS/MIN	60.0
CC/SEC	LITERS/SEC	0.001
CUBIC FT/MIN	LITERS/MIN	28.32

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CENTRAL
SCIENTIFIC

HIGH
VACUUM
EQUIPMENT

THE growing importance of high vacuum technology has greatly increased the need for specialized equipment, both in quality and variety. To meet this need, Central Scientific has greatly increased both its vacuum product line and its facilities for producing these products. Today, Cenco offers the widest choice of vacuum equipment available. In this catalog, you will find vacuum equipment ranging from complete systems down to fittings of all types—equipment to serve production facilities, pilot plants, research laboratories, and educational institutions.

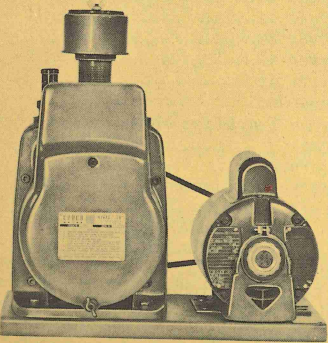
All of the equipment listed in this catalog is available *directly* from Central Scientific Company—both a *manufacturer and distributor*. Prompt service and delivery is assured through Cenco's nation-wide sales and warehouse system backed by Cenco's extensive production facilities and technical staff.

For complete listing of Cenco offices—
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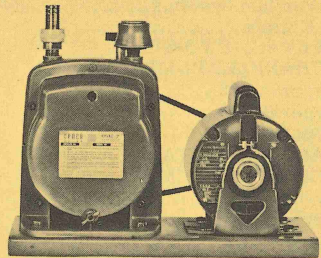
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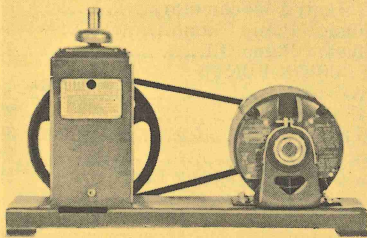
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HYVAC TWO-STAGE PUMPS

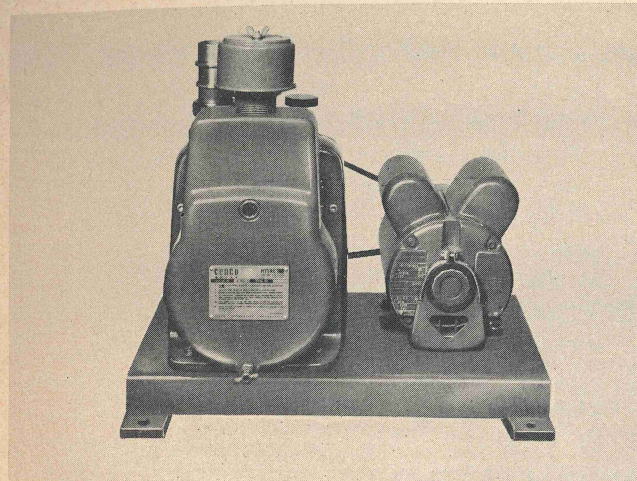


HYVAC SINGLE-STAGE PUMPS



PRESSOVAC SINGLE-STAGE PUMPS

CENCO MECHANICAL VACUUM PUMPS



Since 1920, when the first Hyvac Pump was introduced, Cenco has been engaged in the development and manufacture of vacuum pumps. During this time, Cenco has offered many new pumps to meet the growing needs of vacuum technology while continuously updating and modifying its entire pump line to keep pace with improved manufacturing techniques. Today, with over 43 years of vacuum pump manufacturing behind it, Cenco offers dozens of different mechanical vacuum pumps, all reflecting both modern design and backed by the priceless knowledge gained from experience.

TYPES OF CENCO MECHANICAL PUMPS

Cenco mechanical pumps are rotary, oil-sealed, vane type pumps. In operation, two spring-loaded vanes, mounted on a cylindrical rotating member (rotor) sweep the air from the pump intake to the exhaust as the rotor turns within the housing (stator). The oil serves to both seal the pump from atmosphere and to lubricate the working parts.

Cenco pumps are available in both single-stage and two-stage models. Single-stage models utilize only one stator and rotor (stage) and are useful where the highest vacuum is not required. Two-stage pumps use a second stage connected with the first. The addition of a second stage provides a higher vacuum making two-stage pumps suited for more critical vacuum applications.

APPLICATIONS

Used above or in series with diffusion pumps, oil ejector pumps or booster pumps, Cenco mechanical pumps can serve in such applications as:

- Exhausting electronic tubes
- Distillation procedures
- Packaging operations
- Exhausting environmental chambers
- Vacuum metallurgy
- Vacuum sublimation
- Refrigerator and air-conditioning compressor evacuation
- Freeze-drying of food and drugs

FREE AIR CAPACITY

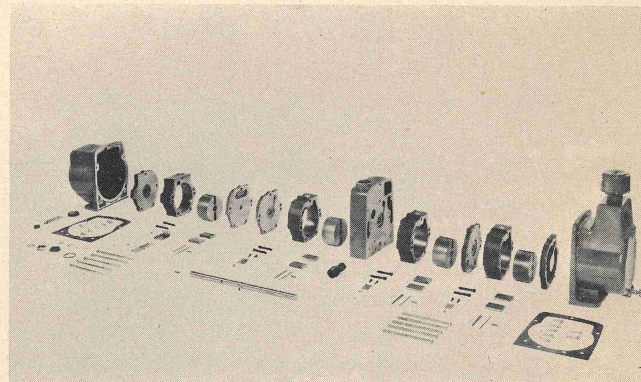
The capacity of a mechanical vacuum pump is measured by the volume of gas that passes through the pump during unit time while the intake is open to atmosphere. This is referred to as the free air capacity and is measured in terms of liters per second or cubic feet per minute. Cenco pumps are available in capacities ranging from 10 to 1500 liters per minute (0.35 to 53 cubic feet per minute) to meet a large number of vacuum needs.

ULTIMATE VACUUM

The ultimate vacuum is the lowest pressure a mechanical pump can produce when pumping against a closed system. This is measured on a trapped McLeod gage (an "absolute" type of gage) and is stated in terms of microns of Hg or the more modern term millitorrs (1×10^{-3} torr).* The ultimate vacuum required of a mechanical pump depends on the type of application. To meet a variety of needs, Cenco offers pumps with ultimate vacuum of from 25 to 0.05 microns of Hg.

GAS BALLAST

Gas ballast is a valve that introduces a small amount of air at atmospheric pressure to the exhaust side of the pump. This causes the pump exhaust valve to open sooner than it normally would and permits water vapor or other condensable vapors to pass to exhaust without condensing. This minimizes contamination of the pump oil and maintains pump performance while making oil changes less frequent. Gas ballast is standard equipment on most Cenco pumps. It can be used either open or, if the system is relatively free of vapor, closed. The ultimate vacuum is always measured with the gas ballast closed.



EASY SERVICING

The techniques used in the manufacture of Cenco pumps assure interchangeability of parts from pump to pump and eliminates the need for selective part fitting. This permits users to service or repair pumps on the spot without the need of special tools and equipment or highly-trained personnel. Parts are stocked in Cenco's coast-to-coast warehouse system and are immediately available to users everywhere. In addition, Cenco offers regular factory repair service at its main plant.

CENCO PUMP PERFORMANCE

Because of its long experience in pump manufacture, Cenco guarantees the ultimate vacuum obtainable with its pumps. Each pump must pass inspection at a lower pressure than the stated guarantee to insure top performance. Cenco handles all phases of manufacturing from machining of castings through final assembly. Every pump is carefully checked during all operations and receives a lengthy "run-in" on a test bench. Because of these strict control procedures, Cenco pumps have gained a reputation for quiet operation and long service under all types of conditions.

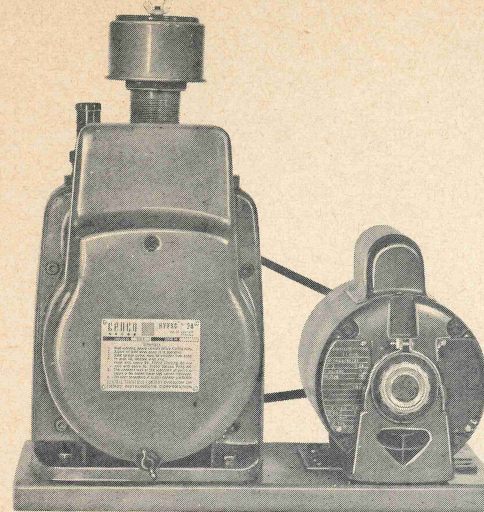
WIDEST CHOICE OF MODELS

To meet the needs of as many users as possible, Cenco offers not only pumps with a wide variety of capacities in single-stage and two-stage models but offers many options in each size. Pumps are available unmounted, mounted on a base without a motor, or mounted with virtually any type of electric motor, both standard and special. Approximately 100 stock models are available and special models can be supplied on request. For industry, research or education, there is a Cenco Vacuum Pump for the job.



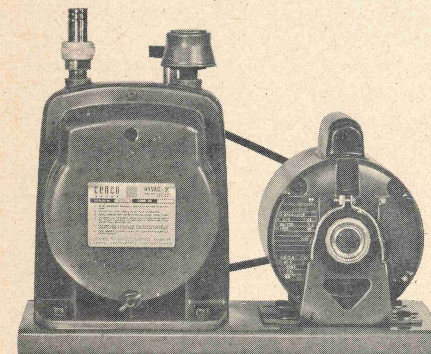
CENTRAL SCIENTIFIC COMPANY

HYVAC TWO-STAGE PUMPS



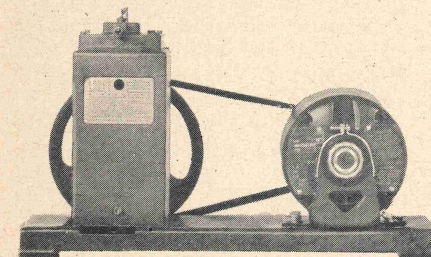
PUMP	FREE AIR CAPACITY LITERS PER MINUTE	GUARANTEED VACUUM MICRONS OF Hg (MILLITORRS)	SEE PAGE
HYVAC 150	1500	0.05	4
HYVAC 45	450	0.05	5
HYVAC 28	280	0.05	6
HYVAC 14	140	0.1	7
HYVAC 7	79	0.1	8
HYVAC 2	25	0.1	10
HYVAC	10	0.3	11

HYVAC SINGLE-STAGE PUMPS



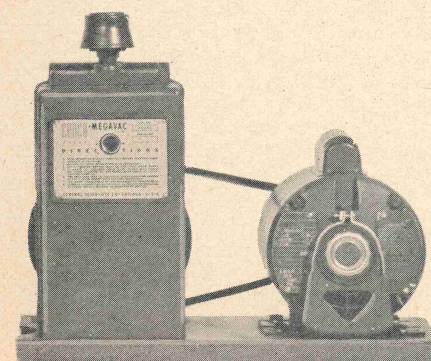
PUMP	FREE AIR CAPACITY LITERS PER MINUTE	GUARANTEED VACUUM MICRONS OF Hg (MILLITORRS)	SEE PAGE
SINGLE STAGE 28	280	5	18
SINGLE STAGE 14	140	5	17
SINGLE STAGE 7	70	10	16

PRESSOVAC SINGLE STAGE PUMPS



TYPE	FREE AIR CAPACITY LITERS PER MINUTE	GUARANTEED VACUUM MICRONS OF Hg (MILLITORRS)	SEE PAGE
WITH PUMP PLATE	35	25	14
WITHOUT PUMP PLATE	35	15	14

OTHER CENCO PUMPS

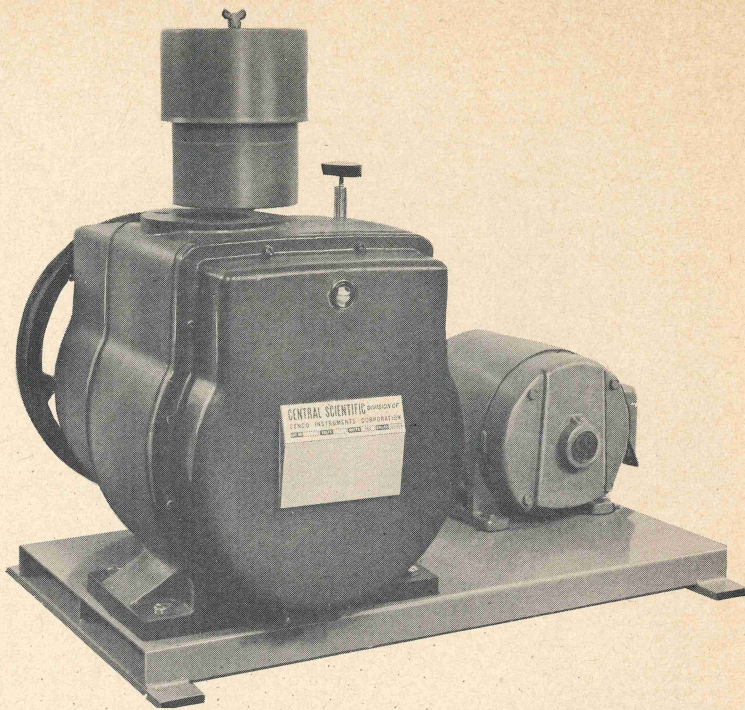


PUMP	FREE AIR CAPACITY LITERS PER MINUTE	GUARANTEED VACUUM MICRONS OF Hg (MILLITORRS)	SEE PAGE
MEGAVAC	57	0.1	9
HYPERVAC 23	240	5.0	12
HYPERVAC 25	264	0.1	12
HYPERVAC 100	960	0.1	13

CENTRAL SCIENTIFIC COMPANY



- Guaranteed vacuum to 0.05 micron of Hg (millitorr)
- Free air capacity of 53 cubic feet (1500 liters) per minute
- New high capacity mechanical pump
- Adjustable gas ballast
- Two-stage, oil-sealed, internal spring mechanism pump



HYVAC 150

TWO-STAGE PUMPS

The Hyvac 150, the largest Cenco mechanical pump, is suited for high capacity tasks such as pumping down environmental chambers, backing diffusion pumps for space simulation or pumping down large vacuum furnaces. Coupled with its large capacity is its remarkable ultimate vacuum of 0.05 micron of Hg. Based on the proven principles of preceding models of Hyvac pumps, the Hyvac 150 is a two-stage internal vane pump. The inner workings are completely submerged in oil to provide a vacuum tight seal of the stages, act as a coolant and to lubricate the working parts. The two stages, intake and exhaust, consist of cylindrical chambers in which concentrically driven rotors are offset to create a high vacuum seal between stator and rotor. Two spring-loaded sliding vanes are fitted into slots in each rotor. Straight forward design and simplified assemblies permit on-location maintenance without the need of special tools. Other features include an easily accessible drain cock, a convenient sight gage to permit checking the oil level, an exhaust filter, and a heavy duty belt guard. The Hyvac 150 is supplied mounted on a base with a standard three-phase motor but can be supplied unmounted or with a special motor if desired.

SPECIFICATIONS

GUARANTEED VACUUM, micron of Hg (millitorr)	0.05
FREE AIR CAPACITY	
Liters per minute	1500
Cubic feet per minute	53
CAPACITY AT 1 MICRON (MILLITORR)	
Liters per minute	1325
Merit factor (%)	85
Normal operating speed, rpm	475
Oil required for one filling, quarts	40
INTAKE FLANGE	
Opening, OD, inches	3 1/8
Bolt circle, OD, inches	5 1/4
Bolt hole, thread	5/8-11 NC
Motor, hp	3
Height, over-all, inches	29 1/2
Width, over-all, inches	22 1/2
Length, over-all, inches	31

MOUNTED WITH MOTOR

The Hyvac 150 is mounted on a substantial metal base together with a high quality 3 hp, ac motor having a grooved pulley. The pump is driven through a set of three molded rubber v-belts. Supplied with the pump are 5 gallons of No. 93050 Cenco-Hyvac Oil, an all-metal belt guard that completely encloses the belt drive, an exhaust filter that effectively traps oil exhaust, and a manual of complete operating instructions.

ORDERING GUIDE

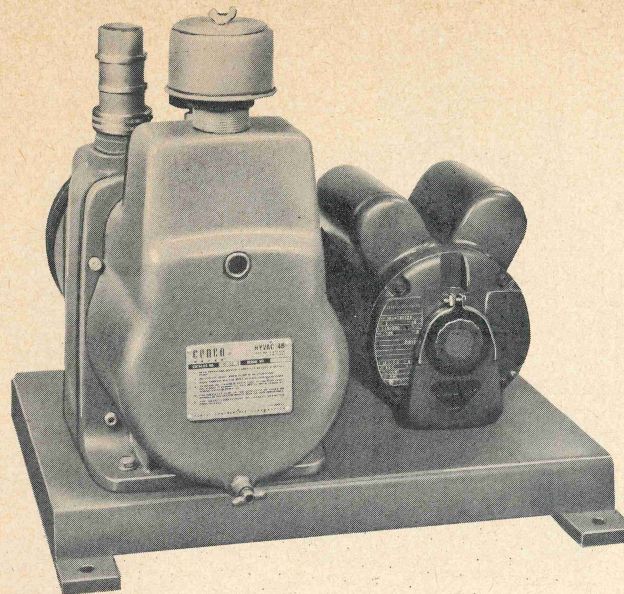
CENCO NO.	MOTOR	TYPE	EACH
91957-1	220/440, 60 cycle, 3-phase		\$1550.00

Special motors are available on request



CENTRAL SCIENTIFIC COMPANY

- Guaranteed vacuum of 0.05 micron of Hg (millitorr)
- Free air capacity of 450 liters per minute
- High speed, high capacity, high vacuum
- Adjustable gas ballast



HYVAC 45

TWO-STAGE PUMPS

SPECIFICATIONS

GUARANTEED VACUUM, micron of Hg (millitorr)	0.05
FREE AIR CAPACITY	
Liters per minute	450
Cubic feet per minute	15.88
CAPACITY AT 1 MILLITORR	
Liters per minute	280
Merit factor (%)	62
Normal operating speed, rpm	550
Oil required for one filling, pints	9
Intake nipple, OD, inches	1.59
Motor, hp	1
Height, over-all, inches	19 1/2
Width, over-all, inches	19 1/4
Length, over-all, inches	21
Net weight, unmounted, lbs.	160
Net weight, mounted, lbs.	210

MOUNTED AND UNMOUNTED PUMPS

Mounted pumps are supplied with a heavy metal base, a high quality, 1 hp motor with grooved pulley, a molded rubber v-belt, 5 quarts of No. 93050 Cenco-Hyvac Oil, and a complete operating manual. Shipping weight is 236 lbs. Unmounted pumps are supplied with 5 quarts of No. 93050 Cenco-Hyvac Oil, a grooved pulley, and a complete set of operating instructions. It is recommended that a 1 hp electric motor with grooved pulley and a v-belt be used to run the pump at 550 rpm. Four mounting holes, 3/8" in diameter and on 7 3/4" and 6" centers, are provided on the pump. Shipping-weight is 195 lbs.

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
91955-1	115/230 V, 60 cycle	\$625.00
91955-7	115/230 V, 50 cycle	650.50
91955-10	115/230 V, 60 cycle*	738.50
91955-18	220/440 V, 50/60 cycle, 3-phase	640.00
91955-23	Mounted without motor	560.00
91950	Unmounted pump only	525.00

Special motors are available on request.

*explosion proof

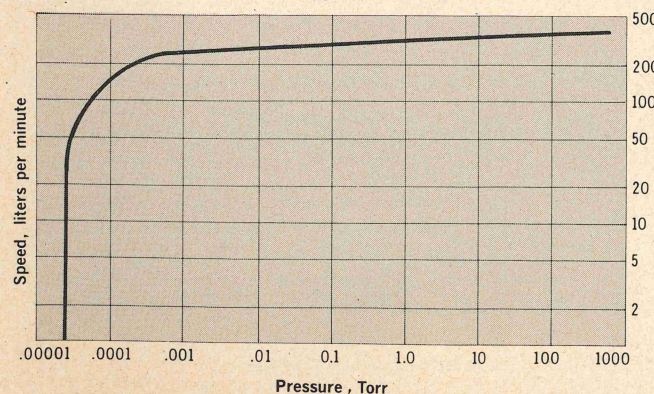
NO. 91708	Belt Guard for above	\$15.50
NO. 91132-14	Replacement V-Belt for above	\$2.35
NO. 18205-14	1 1/2-Inch ID Rubber Tubing for above	\$2.85 per ft.

The Hyvac 45 High Vacuum Pump is the largest two-stage model of the famous Cenco-Hyvac family of pumps. An essential piece of equipment in laboratories and pilot plants where specialized work in vacuum is being conducted. Improved internal design and engineering features plus solid contact mounting to the heavy steel base have reduced the noise level to a minimum. The adjustable gas ballast eliminates the need for cold traps and numerous oil changes. Condensable vapors that would normally build up inside most pumps are immediately discharged through the exhaust dome.

The pumping unit is submerged in a high quality, specially compounded, low vapor pressure oil. This insures a vacuum tight seal of the stages, acts as a coolant, and lubricates the moving parts. The two stages, intake, and exhaust consist of cylindrical chambers in which concentrically driven rotors are offset to create a high vacuum seal between rotor and stator. Two sliding vanes are fitted into slots in each rotor. As the rotors are driven, the vanes allow a volume of gas to be expanded, cut off, compressed and exhausted to ambient pressure. Lubricating oil for the stages enters through a metering hole in the exhaust stage allowing the oil to be degassed before entering the intake stage.

Straight forward design and the absence of complicated assemblies permits on-location maintenance without special tools. Other features include an easily accessible drain cock and conveniently located sight gage that provides a quick check of the oil level. A specially developed Cenco-Hyvac Oil, No. 93050, is provided to insure maximum performance. For cleaning, it is recommended that No. 93060 Cenco-Hyvac Flushing Oil be used. The Hyvac 45 is equipped with a one-piece intake nipple intended primarily for use with rubber tubing. All units are attractively finished in blue-gray enamel. Available unmounted or mounted with a wide choice of motors.

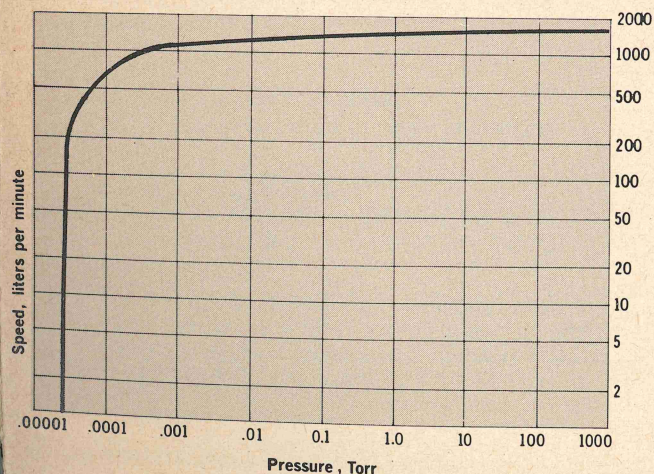
SPEED-PRESSURE CURVE



CENTRAL SCIENTIFIC COMPANY



SPEED PRESSURE CURVE



- Guaranteed vacuum of 0.05 micron of Hg (millitorr)
- Free air capacity of 280 liters per minute
- Higher pumping speed to a lower ultimate vacuum
- Adjustable gas ballast

HYVAC 28

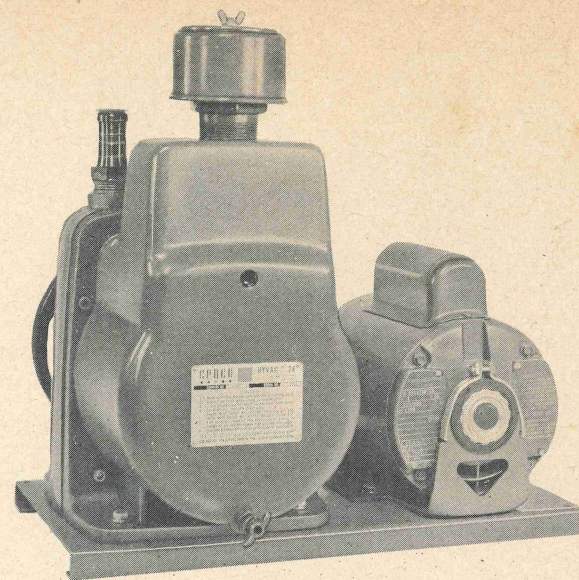
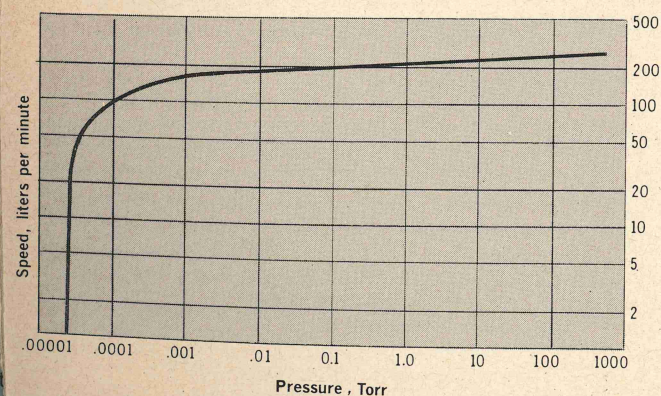
TWO-STAGE PUMPS

The Hyvac 28 High Vacuum Pump offers exceptionally fast pumping speed for a pump of its size and price. An ideal pump for backing a high-speed diffusion pump or directly evacuating a system. The Hyvac 28 will evacuate a cubic foot system down to diffusion pump operating level in less than two minutes. Solid contact mounting to the heavy steel base plus improved internal design and engineering features have reduced the noise level to a minimum. The adjustable gas ballast eliminates the need for cold traps and numerous oil changes.

The pumping unit is submerged in a high quality, specially compounded, low vapor pressure oil. This insures a vacuum tight seal of the stages, acts as a coolant and lubricates the moving parts. The two stages, intake and exhaust, consist of cylindrical chambers in which concentrically driven rotors are offset to create a high vacuum seal between rotor and stator. Two sliding vanes are fitted into slots in each rotor. As the rotors are driven, the vanes allow a volume of gas to be expanded, cut off, compressed and exhausted to ambient pressure. Lubricating oil for the stages enters through a metering hole in the exhaust stage allowing the oil to be degassed before entering the intake stage.

Straight forward design and the absence of complicated assemblies permits on-location maintenance without special tools. Other features include an easily accessible drain cock and conveniently located sight gage that provides a quick check of the oil level. A specially developed Cenco-Hyvac Oil, No. 93050, is provided to insure maximum performance. For cleaning, it is recommended that No. 93060 Cenco-Hyvac Flushing Oil be used. The Hyvac 28 is equipped with a one-piece intake nipple intended primarily for use with rubber tubing. All units are attractively finished in blue-gray enamel. Available unmounted or mounted with a wide choice of motors.

SPEED-PRESSURE CURVE



SPECIFICATIONS

GUARANTEED VACUUM, micron of Hg (millitorr)	0.05
FREE AIR CAPACITY	
Liters per minute	280
Cubic feet per minute	9.88
CAPACITY AT 1 MILLITORR	
Liters per minute	150
Merit factor (%)	54
Normal operating speed, rpm	525
Oil required for one filling, pints	7
Intake nipple, OD, inches	1.09
Motor, hp	1
Height, over-all, inches	18 1/4
Width, over-all, inches	15 1/2
Length, over-all, inches	18
Net weight, unmounted, lbs.	116
Net weight, mounted, lbs.	147

MOUNTED AND UNMOUNTED PUMPS

Mounted pumps are supplied with a heavy metal base, a high quality 1 hp motor with grooved pulley, a molded rubber v-belt, 1 gallon of No. 93050 Cenco-Hyvac Oil, and a complete operating manual. Shipping weight is 171 lbs.

Unmounted pumps are supplied with 1 gallon of No. 93050 Cenco-Hyvac Oil, a grooved pulley, and a complete operating manual. It is recommended that a 1 hp electric motor with grooved pulley and a v-belt be used to run the pump at 525 rpm. Four mounting holes, 3/8" in diameter and on 7" and 6" centers, are provided on the pump. Shipping weight is 135 lbs.

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
91905-1	115/230 V, 60 cycle	\$550.00
91905-7	115/230 V, 50 cycle	575.50
91905-10	115/230 V, 60 cycle	663.50
91905-18	220/440 V, 50/60 cycle, 3-phase	565.00
91905-23	Mounted without motor	485.00
91900	Unmounted pump only	475.00
Special motors are available on request.		*explosion proof
NO. 91708	Belt Guard for above	\$15.50
NO. 91132-14	Replacement V-Belt for above	\$2.35
NO. 18205-12	1-Inch ID Rubber Tubing for above	\$2.05 per ft.



CENTRAL SCIENTIFIC COMPANY

- Guaranteed vacuum to 0.1 micron of Hg (millitorr)
- Free air capacity of 140 liters per minute
- Two-stage, series-connected, oil-sealed pump utilizing the internal vane principle
- Adjustable gas ballast

HYVAC 14

TWO-STAGE PUMPS

SPECIFICATIONS

GUARANTEED VACUUM, micron of Hg (millitorr)	0.1
FREE AIR CAPACITY	
Liters per minute	140
Cubic feet per minute	4.94
CAPACITY AT 1 MILLITORR	
Liters per minute	75
Merit factor (%)	54
Normal operating speed, rpm	525
Oil required for one filling, pints	5
Intake nipple, OD, inches	7/8
Motor, hp	1 1/2
Height, over-all, inches	15 3/4
Width, over-all, inches	12 3/4
Length, over-all, inches	17 7/8
Net weight, unmounted, lbs.	91
Net weight, mounted, lbs.	119

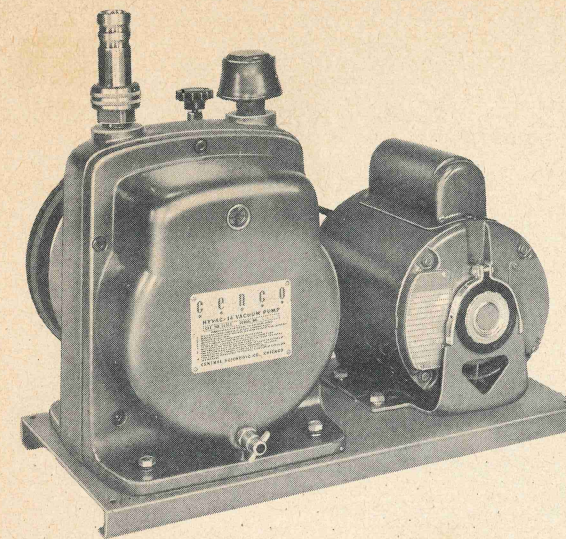
MOUNTED AND UNMOUNTED PUMPS

Mounted pumps are provided with a heavy metal base, a high quality 1/2 hp motor with grooved pulley, a molded rubber v-belt, 1 gallon of No. 93050 Cenco-Hyvac Oil and a complete operating manual. Shipping weight is 141 lbs.

Unmounted pumps are supplied with 1 gallon of No. 93050 Cenco-Hyvac Oil, a grooved pulley, and a complete operating manual. It is recommended that a 1/2 hp electric motor with grooved pulley and v-belt be used to operate the pump at 525 rpm. Four mounting holes, 3/8" in diameter and on 7" and 6" centers, are provided on the pump. Shipping weight is 106 lbs.

ORDERING GUIDE

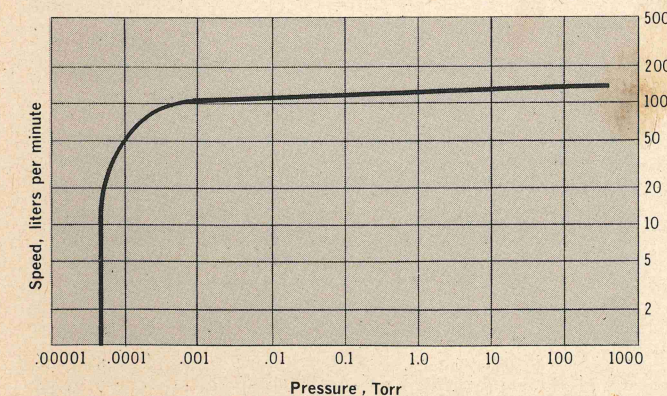
CENCO NO.	MOTOR RATING	EACH
91705-1	115/230 V, 60 cycle	\$388.00
91705-7	115/230 V, 50 cycle	402.00
91705-10	115/230 V, 60 cycle*	425.50
91705-18	220/440 V, 50/60 cycle, 3-phase	396.00
91705-23	Mounted without motor	340.00
91700	Unmounted pump only	310.50
Special motors are available on request.		*explosion proof
NO. 91708	Belt Guard for above	\$15.50
NO. 91132-14	Replacement V-Belt for above	\$2.35
NO. 18205-12	1-Inch ID Rubber Tubing for above	\$2.05 per ft.



The Hyvac 14 Vacuum Pump is ruggedly constructed of the finest materials for long life and dependability. The gas ballast prevents contamination of the pump oil when pumping condensable vapors and eliminates the need for numerous oil changes. The pumping unit is submerged in a high quality, specially compounded, low vapor pressure oil. This insures a vacuum tight seal of the stages, acts as a coolant and lubricates the moving parts. The two stages, intake and exhaust, consist of cylindrical chambers in which concentrically driven rotors are offset to create a high vacuum seal between rotor and stator. Two sliding vanes are fitted into slots in each rotor. As the rotors are driven, the vanes allow a volume of gas to be expanded, cut off, compressed and exhausted to ambient pressure. Lubricating oil for the stages enters through a metering hole in the exhaust stage allowing the oil to be degassed before entering the intake stage.

Straight forward design and the absence of complicated assemblies permits on-location maintenance without special tools. Other features include an easily accessible drain cock and conveniently located sight gage that provides a quick check of the oil level. A specially developed Cenco-Hyvac Oil, No. 93050, is provided to insure maximum performance. For cleaning, it is recommended that No. 93060 Cenco-Hyvac Flushing Oil be used. The Hyvac 14 Vacuum Pump is equipped with a coupling hose nipple and vacuum coupling nut, intended for use with rubber or metal tubing. All units are attractively finished in blue-gray enamel. Available unmounted or mounted with a wide choice of motors.

SPEED PRESSURE CURVE



CENTRAL SCIENTIFIC COMPANY



- Guaranteed vacuum to 0.1 micron of Hg (millitorr)
- Free air capacity of 79 liters per minute
- Two-stage, series-connected, oil-sealed pump
- Adjustable gas ballast

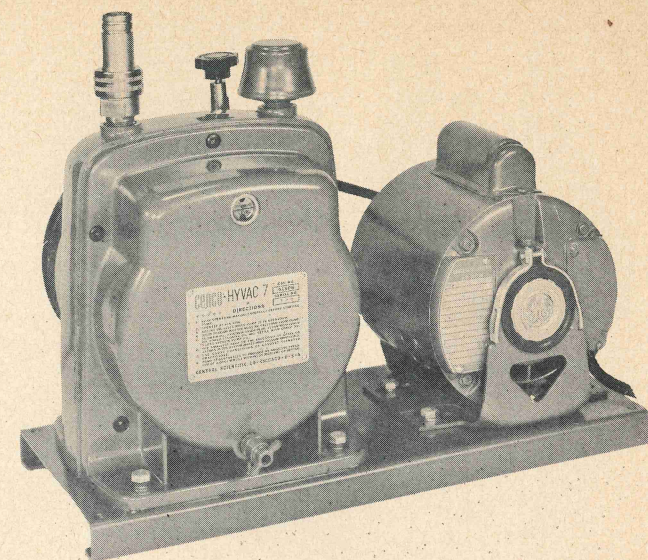
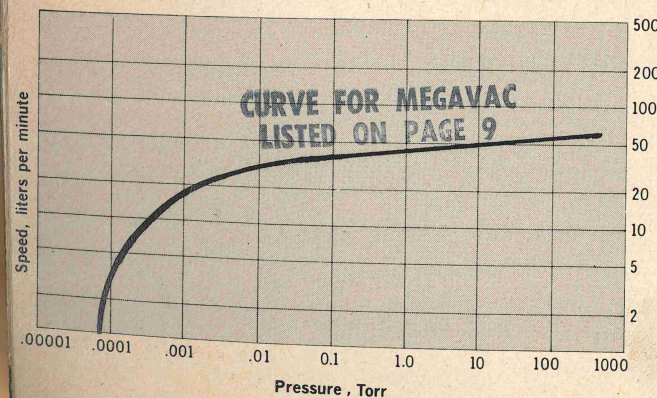
HYVAC 7

TWO-STAGE PUMPS

The Hyvac 7 Vacuum Pump is ideally suited for applications requiring vacuum in the low millitorr range. The gas-ballast prevents contamination of the pump oil when pumping condensable vapors and eliminates the need for numerous oil changes. The pumping unit is submerged in a high quality specially compounded, low vapor pressure oil. This insures a tight seal of the stages, acts as a coolant and lubricates the moving parts. The two stages, intake and exhaust, consist of cylindrical chambers in which concentrically driven rotors are offset to create a high vacuum seal between rotor and stator. Two sliding vanes are fitted into slots in each rotor. As the rotors are driven, the vanes allow a volume of gas to be expanded, cut off, compressed and exhausted to ambient pressure. Lubricating oil for the stages enters through a metering hole in the exhaust stage allowing the oil to be degassed before entering the intake stage.

Straight forward design and the absence of complicated assemblies permits on-location maintenance without special tools. Other features include an easily accessible drain cock and conveniently located sight gage that provides a quick check of the oil level. A specially developed Cenco-Hyvac Oil, No. 93050, is provided to insure maximum performance. For cleaning it is recommended that No. 93060 Cenco-Hyvac Flushing Oil be used. The Hyvac 7 Vacuum Pump is equipped with a coupling hose nipple and vacuum coupling nut intended for use with rubber or metal tubing. All units are attractively finished in blue-gray enamel. Available mounted or unmounted with a wide choice of motors.

SPEED PRESSURE CURVE



SPECIFICATIONS

GUARANTEED VACUUM, micron of Hg (millitorr)	0.1
FREE AIR CAPACITY	
Liters per minute	79
Cubic feet per minute	2.79
CAPACITY AT 1 MILLITORR	
Liters per minute	35
Merit factor (%)	44
Normal operating speed, rpm	525
Oil required for one filling, pints	3
Intake nipple, OD, inches	0.91
Motor, hp	1/3
Height, over-all, inches	13
Width, over-all, inches	11 1/2
Length, over-all, inches	17 1/4
Net weight, unmounted, lbs.	72
Net weight, mounted, lbs.	98

MOUNTED AND UNMOUNTED PUMPS

Mounted pumps are supplied with a heavy metal base, a high quality, 1 hp motor with grooved pulley, a molded rubber v-belt, 5 quarts of No. 93050 Cenco-Hyvac Oil, and a complete operating manual. Shipping weight is 236 lbs.

Unmounted pumps are supplied with 5 quarts of No. 93050 Cenco-Hyvac Oil, a grooved pulley, and a complete set of operating instructions. It is recommended that a 1 hp electric motor with grooved pulley and a v-belt be used to run the pump at 550 rpm. Four mounting holes, 3/8" in diameter and on 7 3/4" and 6" centers, are provided on the pump. Shipping weight is 195 lbs.

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
91506-1	115/230 V, 60 cycle	\$284.25
91506-7	115/230 V, 50 cycle	292.50
91506-10	115/230 V, 60 cycle*	324.50
91506-18	220/440 V, 50/60 cycle, 3-phase	298.50
91506-23	Mounted without motor	240.00
91502	Unmounted pump only	227.50
Special motors are available on request. *explosion proof		
NO. 91708	Belt Guard for above	\$15.50
NO. 91132-7	Replacement V-Belt for above	\$1.80
NO. 18205-10	3/4-Inch ID Rubber Tubing for above	\$1.95 per ft.



CENTRAL SCIENTIFIC COMPANY

- Guaranteed vacuum to 0.1 micron of Hg (millitorr)
- Free air capacity of 57 liters per minute
- Two-stage, oil-sealed, internal spring mechanism pump
- Highly efficient and compact

MEGAVAC

TWO-STAGE PUMPS

SPECIFICATIONS

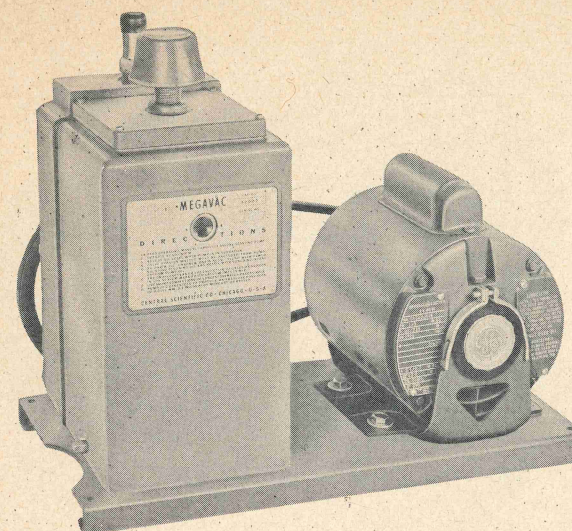
GUARANTEED VACUUM, micron of Hg (millitorr)	0.1
FREE AIR CAPACITY	
Liters per minute	57
Cubic feet per minute	2.0
CAPACITY AT 1 MILLITORR	
Liters per minute	22
Merit factor (%)	37
Normal operating speed, rpm	600
Oil required for one filling, quarts	3
Intake nipple, OD, inches	0.81
Motor, hp	1/3
Height, over-all, inches	14 1/2
Width, over-all, inches	10 3/4
Length, over-all, inches	17 1/2
Net weight, unmounted, lbs.	72
Net weight, mounted, lbs.	99

UNMOUNTED PUMP ONLY

The unmounted Megavac High Vacuum Pump is supplied with a grooved pulley. Four mounting holes, 9/32" diameter on 7" and 7 1/4" centers, are provided in the sub-base of the pump. Also supplied is 1 gallon of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. It is recommended that a 1/3 hp electric motor with grooved pulley and a V-belt be used. For best performance, the pump should be run at 600 rpm. Shipping weight is 110 lbs.

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
92003-1	115/230 V, 60 cycle	\$258.50
92003-7	115/230 V, 50 cycle	265.25
92003-10	115/230 V, 60 cycle	295.00
92003-18	220/440 V, 50/60 cycle, 3-phase	271.00
92003-23	Mounted without motor	202.00
92001	Unmounted pump only	189.50
Special motors are available on request. *explosion proof		
NO. 91708	Belt Guard for above	\$15.50
NO. 92006	Replacement V-Belt for above	\$2.00
NO. 18204-11	1 1/8-Inch ID Rubber Tubing for above	\$1.70 per ft.



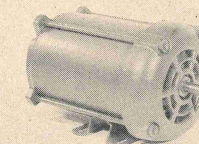
The Megavac High Vacuum Pump is widely used for the evacuation of larger laboratory appliances and for industrial applications such as the production of luminous tubes, television tubes and similar products. It may be used direct or in connection with diffusion pumps. In many instances where diffusion pumps were formerly required, the Megavac may be used with a liquid air trap eliminating the extra pump. The entire pumping mechanism is completely immersed in oil. This insures a vacuum-tight seal of the stages, acts as a coolant and lubricates the moving parts.

The Megavac features a positive sealing ring which stops leakage around the shaft, a leakproof cover, an easily accessible drain cock and a conveniently located sight-gage for a quick check of the oil level. The Megavac High Vacuum Pump is equipped with a one-piece intake nipple intended for use with rubber tubing. All units are attractively finished in blue-gray enamel. Available unmounted or mounted with a wide choice of motors.

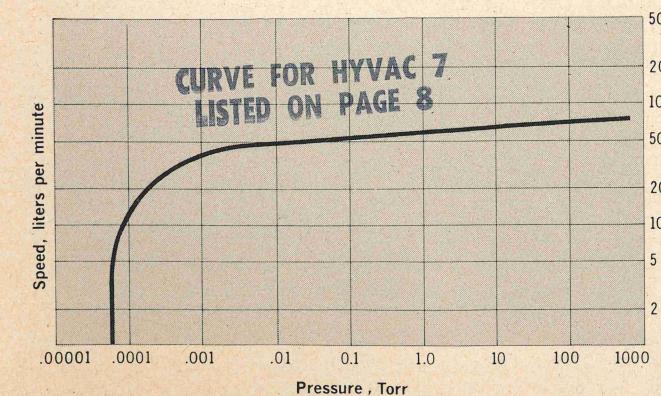
MOUNTED WITH MOTOR

The mounted Megavac High Vacuum Pump is supplied with a high quality 1/3" hp, ac motor with grooved pulley, a No. 92006 molded rubber V-belt, 1 gallon of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. A 3-wire line cord and plug with switch is supplied with -1 and -7 pumps only. Shipping weight is 110 lbs.

All models of Cenco vacuum pumps are available with EXPLOSION PROOF MOTORS.



SPEED-PRESSURE CURVE



CENTRAL SCIENTIFIC COMPANY



- Guaranteed vacuum to 0.1 micron of Hg (millitorr)
- Free air capacity of 25 liters per minute
- Two-stage, series-connected, oil-sealed pump
- Optional gas ballast

HYVAC 2

TWO-STAGE PUMPS

The Hyvac 2 Vacuum Pump is a compact, highly efficient two-stage pump used by scientists the world over for the exhaustion of vessels, chambers and other vacuum systems in analytical procedures and research investigations. The pumping unit is submerged in a high quality, specially compounded, low vapor pressure oil. This insures a vacuum tight seal of the stages, acts as a coolant and lubricates the moving parts. The two stages, intake and exhaust, consist of cylindrical chambers in which concentrically driven rotors are offset to create a high vacuum seal between rotor and stator. Two sliding vanes are fitted into slots in each rotor. As the rotors are driven, the vanes allow a volume of gas to be expanded, cut off, compressed and exhausted to ambient pressure. Lubricating oil for the stages enters through a metering hole in the exhaust stage allowing the oil to be degassed before entering the intake stage.

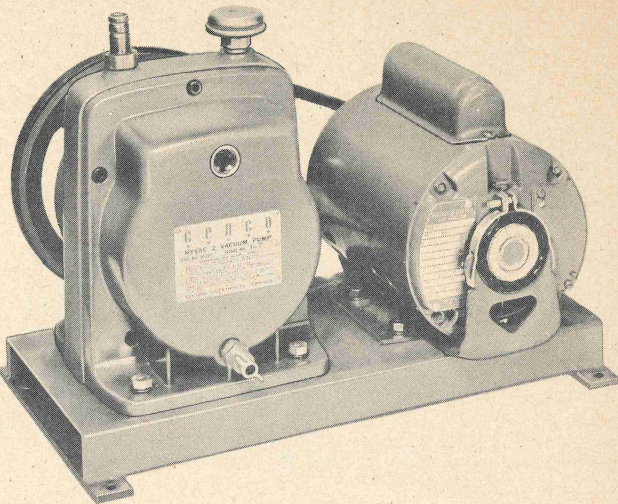
Straight forward design and the absence of complicated assemblies permits on-location maintenance without special tools. Other features include an easily accessible drain cock and conveniently located sight gage that provides a quick check of the oil level. A specially developed Cenco-Hyvac Oil, No. 93050, is provided to insure maximum performance. For cleaning, it is recommended that No. 93060 Cenco-Hyvac Flushing Oil be used. The Hyvac 2 Vacuum Pump is equipped with a one-piece intake nipple intended primarily for use with rubber tubing. All units are attractively finished in blue-gray enamel. Available with or without gas ballast, unmounted, or mounted with a wide choice of motors.

MOUNTED WITH MOTOR

The mounted Hyvac 2 Vacuum Pump is supplied with a high quality 1/4 hp, ac motor with grooved pulley, a No. 91132-2 molded rubber V-belt, 3 pints of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. A 3-wire cord and plug with switch is supplied with -1 and -7 pumps only. Shipping weight is 74 lbs.

UNMOUNTED PUMP ONLY

The unmounted Hyvac 2 Vacuum Pump is supplied with a grooved pulley. Four mounting holes, 3/8" in diameter on 4 1/2" and 4 3/4" centers are provided in the base of the pump. Also included is 3 pints of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. It is recommended that a 1/4 hp electric motor with a grooved pulley and a V-belt be used. For best performance, the pump should be run at 580 rpm. Shipping weight is 45 lbs.



SPECIFICATIONS

GUARANTEED VACUUM, microns of Hg (millitorr)	0.1
FREE AIR CAPACITY	
Liters per minute	25
Cubic feet per minute	0.88
CAPACITY AT 1 MILLITORR	
Liters per minute	13
Merit factor (%)	52
Normal operating speed, rpm	580
Oil required for one filling, quarts	1
Intake nipple, OD, inches	0.56
Motor, hp	1/4
Height, over-all, inches	11
Width, over-all, inches	10
Length, over-all, inches	15
Net weight, unmounted, lbs.	39
Net weight, mounted, lbs.	66

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
91305-1	115/230 V, 60 cycle	\$165.00
91305-7	115/230 V, 50 cycle	185.00
91305-10	115 V, 60 cycle*	210.00
91305-18	220/440 V, 50/60 cycle, 3-phase	195.00
91305-23	Mounted without motor	139.75
91300	Unmounted without motor	132.50

Special motors are available on request. *explosion proof

ORDERING GUIDE - GAS-BALLAST

CENCO NO.	MOTOR RATING	EACH
91308-1	115 V, 60 cycle	\$181.00
91308-2	230 V, 60 cycle	184.00
91308-7	115 V, 50 cycle	191.50
91308-8	230 V, 50 cycle	194.50
91308-10	115 V, 60 cycle*	217.50
91308-18	220/440 V, 50/60 cycle, 3 phase	201.75
91308-23	Mounted without motor	151.00
91306	Unmounted pump only	139.50

Special motors are available on request. *explosion proof.

NO. 91508	Belt Guard for above	\$15.50
NO. 91132-2	Replacement V-Belt for above	\$1.80
NO. 18204-6	3/16-Inch ID Rubber Tubing for above	\$1.05 per ft.



CENTRAL SCIENTIFIC COMPANY

- Guaranteed vacuum to 0.3 micron of Hg (millitorr)
- Free air capacity of 10 liters per minute
- Two-stage, series-connected, rotary type, oil sealed pump
- Improved exhaust dome and baffle eliminate oil spray from the pump

HYVAC

TWO-STAGE PUMPS

SPECIFICATIONS

GUARANTEED VACUUM, microns of Hg (millitorr)	0.3
FREE AIR CAPACITY	
Liters per minute	10
Cubic feet per minute	0.35
CAPACITY AT 1 MILLITORR	
Liters per minute	4.6
Merit factor (%)	46
Normal operating speed, rpm	350
Oil required for one filling, quarts	1
Intake nipple, OD, inches	3/8
Motor, hp	1/4
Height, over-all, inches	10 3/4
Width, over-all, inches	10
Length, over-all, inches	18 1/2
Net weight, unmounted, lbs.	23
Net weight, mounted, lbs.	42

MOUNTED WITH MOTOR

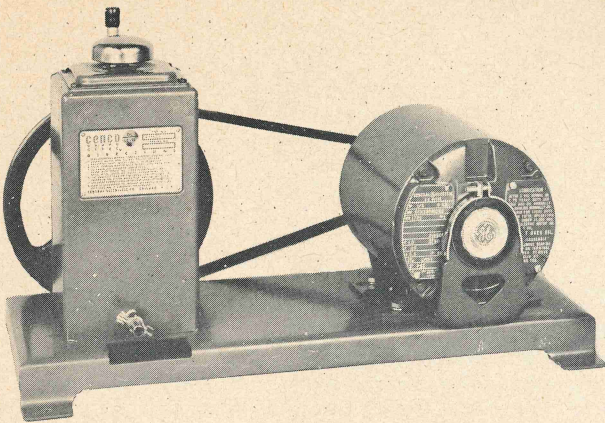
The mounted Hyvac Vacuum Pump is supplied with a high quality 1/4 hp motor with grooved pulley, No. 91131 molded rubber V-belt and 1 quart of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. All -1 through -8 pumps are supplied with a 3-wire line cord and plug with switch. All ac motors are single phase. Shipping weight is 47 lbs.

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
91105-1	115 V, 60 cycle	\$127.50
91105-2	230 V, 60 cycle	129.25
91105-3	115 V, dc	171.00
91105-4	230 V, dc	165.50
91105-5	115 V, 25 cycle	150.00
91105-7	115 V, 50 cycle	129.25
91105-8	230 V, 50 cycle	134.50
91105-10	115 V, 60 cycle*	150.00
91105-23	Mounted without motor	101.00
91100	Unmounted pump only	92.50

Special motors are available on request. *explosion proof

NO. 91135	Belt Guard for above	\$14.75
NO. 91131	Replacement V-Belt for above	\$2.00
NO. 18204-6	3/16-Inch ID Rubber Tubing for above	\$1.05 per ft.



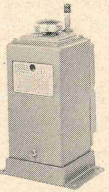
This small but powerful vacuum pump of proven dependability has been the standard for many years in industry and education. The pumping unit, made of precision machined parts, is completely immersed in high vacuum, low vapor pressure sealing oil. This insures a vacuum tight seal of the stages, serves as a coolant and lubricates the moving parts.

A built-in trap prevents foreign matter from entering into the mechanism and eliminates oil "back up" when the pump is stopped. An improved exhaust dome and baffle eliminates oil spray from the pump. An oil level sight gage and drain cock are conveniently located on the housing. The Hyvac Vacuum Pump is equipped with a one-piece intake nipple intended primarily for use with rubber tubing. Available unmounted or mounted with a wide choice of motors. All units are attractively finished in blue-gray enamel.

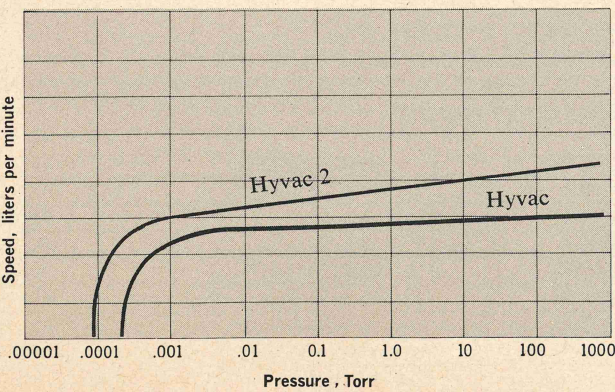
UNMOUNTED PUMP ONLY

The unmounted Hyvac Vacuum Pump is supplied with a grooved pulley. Four mounting holes, 1/4" diameter on 5 1/2" and 2-15/16" centers, are provided in the sub-base. Also included is 1 quart of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. It is recommended that a 1/4 hp electric motor with grooved pulley and a V-belt be used. For best performance, the pump should be run at 350 rpm. Shipping weight is 25 lbs.

Cenco vacuum pumps are also available unmounted.

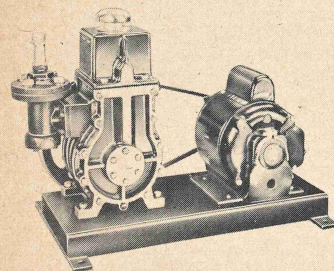
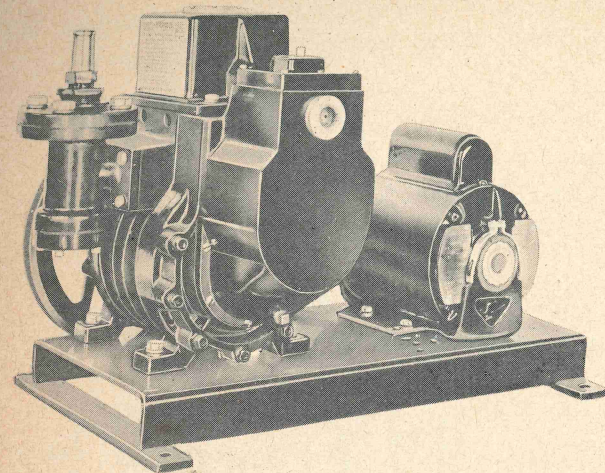


SPEED-PRESSURE CURVE



CENTRAL SCIENTIFIC COMPANY





HYPERVAC 23

GUARANTEED VACUUM, millitorr	5.0
FREE AIR CAPACITY	
Liters per minute	240
Cubic feet per minute	8.47

The Hypervac 23 is a two-stage high vacuum pump. The high vacuum or finishing stage operates on the principle of the eccentric rotor with spring-actuated moving vane. The roughing stage consists of a reciprocating pump utilizing the vane motion of the finishing stage. Requires little oil for operation.

MOUNTED WITH MOTOR

The mounted Hypervac 23 High Vacuum Pump is supplied with a high quality 1/2 hp motor with grooved pulley, a No. 92020 molded rubber V-belt, 3 pints of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. Shipping weight is 177 lbs.

UNMOUNTED PUMP ONLY

The unmounted Hypervac 23 High Vacuum Pump is supplied with a grooved pulley, a sub-base, 3 pints of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. It is recommended that a 1/2 hp electric motor with grooved pulley and a V-belt be used. For best performance, the pump should be run at 510 rpm. Shipping weight is 132 lbs.

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
93006-1	115/230 V, 60 cycle	\$512.00
93006-3	115 V, dc	501.00
93006-5	115/230 V, 25 cycle	548.00
93006-7	115/230 V, 50 cycle	517.00
93006-10	115/230 V, 60 cycle*	555.50
93006-18	220/440 V, 60 cycle, 3-phase	512.00
93006-23	Mounted without motor	470.50
93001	Unmounted pump only	460.00

Special motors are available on request.

*explosion proof

HYPERVAC 25

The Hypervac 25 is a two-stage high vacuum pump widely used in experimental and production work. The high vacuum or intake stage operates on the principle of the eccentric rotor with a spring-actuated moving vane. A complete Cenco Pressovac unit is used for the roughing stage of the Hypervac 25. The stages are separated by a small compartment that contains a spring operated by-pass valve. When the pump is started or opened to a large system, the first quantity of air is forced through the by-pass valve. As pressure is reduced, this valve closes and the backing pump reduces the pressure in the compartments separating the two stages. Low pressure in this compartment makes possible the attainment of high vacuum at the intake port. Other features include an easily accessible drain cock and a conveniently located sight gage for a quick check on the oil level. The Hypervac 25 is equipped with a 1 1/4" IPS cast iron flange with an intake nipple for use with rubber tubing 13/16" inside diameter. All units are finished in blue-gray enamel. Available unmounted or mounted with a wide choice of motors.

MOUNTED WITH MOTOR

The mounted Hypervac 25 High Vacuum Pump is supplied with a high quality 3/4 hp, ac or dc motor with grooved pulley, a No. 92020 molded rubber V-belt, 1 gallon of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. Shipping weight is 209 lbs.

UNMOUNTED PUMP ONLY

The unmounted Hypervac 25 High Vacuum Pump is supplied with a grooved pulley, a sub-base, 1 gallon of No. 93050 Cenco-Hyvac Oil and a manual of complete operating instructions. It is recommended that a 3/4 hp electric motor with grooved pulley and a V-belt be used. For best performance, the pump should be run at 570 rpm. Shipping weight is 168 lbs.

SPECIFICATIONS

GUARANTEED VACUUM, millitorr	0.1
FREE AIR CAPACITY	
Liters per minute	264
Cubic feet per minute	8.31
CAPACITY AT 1 MILLITORR	
Liters per minute	120
Merit factor (%)	45
Normal operating speed, rpm	570
Oil required for one filling, quarts	2
Intake nipple, OD, inches	1.09
Motor, hp	3/4
Height, over-all, inches	18
Width, over-all, inches	17 1/2
Length, over-all, inches	26
Net weight, unmounted, lbs.	135
Net weight, mounted, lbs.	180

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
93020-1	115/230 V, 60 cycle	\$672.00
93020-3	115 V, dc	770.50
93020-7	115/230 V, 50 cycle	680.50
93020-10	115/230 V, 60 cycle*	741.50
93020-18	220/440 V, 60 cycle, 3-phase	677.50
93020-23	Mounted without motor	606.00
93010	Unmounted pump only	601.00

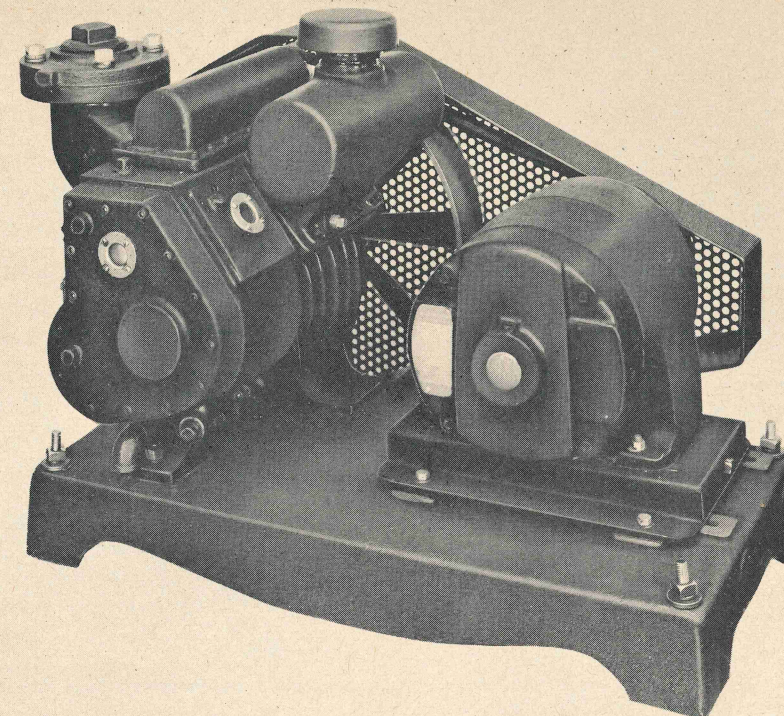
Special motors are available on request.

*explosion proof



CENTRAL SCIENTIFIC COMPANY

HYPERVAC 100



- Guaranteed vacuum to 0.1 micron of Hg (millitorr)

- Free air capacity of 960 liters per minute

- Capacity at 1 millitorr is 660 liters per minute

- Equipped with a backing pump

- A rotary, oil-sealed pump operating on the principle of the eccentric rotor with spring-actuated moving vane

The Hypervac 100 High Vacuum Pump is the largest of the Cenco line. It is a two-stage vacuum pump with an operating principle similar to the Hypervac 25. Its extremely high rate of displacement and low ultimate pressure make it invaluable for the evacuation of very large volumes not ordinarily possible with commercial pumps unless used with external backing pumps. Laboratory tests have shown repeated readings as low as 0.02 millitorr. A complete Cenco-Pressovac pump provides the roughing stage and is an integral part of the pump. No. 94002 Freezing Trap is designed for use with this pump. Other features include 2 drain cocks and 2 conveniently located sight-gages for a quick check of the oil level.

The Hypervac 100 intake is machined to receive a standard 3" cast iron flange. This flange is included with the pump. For maximum pumping speed at low pressure, 3" ID tubing is recommended. When large quantities of air are to be passed through the pump, a 2 1/2" pipe may be attached to the exhaust chamber and extended outside the pump room. The Hypervac 100 is finished in blue-gray enamel.

SPECIFICATIONS

GUARANTEED VACUUM, millitorr	0.1
FREE AIR CAPACITY	
Liters per minute	960
Cubic feet per minute	33.9
CAPACITY AT 1 MILLITORR	
Liters per minute	660
Merit factor (%)	69
Normal operating speed, rpm	450
Oil required for one filling, quarts	5
Intake nipple, OD, inches	3
Motor, ac, 3-phase, hp	2
Height, over-all, inches	24 1/4
Width, over-all, inches	24 1/2
Length, over-all, inches	24 1/2
Net weight, mounted, lbs.	570

MOUNTED WITH MOTOR

The Hypervac 100 High Vacuum Pump is supplied with a high quality 2 hp, 3-phase, ac motor, 3 No. 93035 molded rubber V-belts working from a triple-grooved motor-pulley to an 18" flat faced pump sheave, 5 quarts of No. 93055 Cenco-Hyvac Oil and a manual of complete operating instructions. Shipping weight is 670 lbs.

ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
93033	220/440 V, 60 cycle, 3-phase	\$2326.50

Motors with other current specifications are available on request.



CENTRAL SCIENTIFIC COMPANY

- Guaranteed vacuum to 15 microns of Hg (millitorrs)
- Guaranteed vacuum with pump plate to 25 millitorrs
- Free air capacity of 35 liters per minute
- Designed for moderate vacuum and pressure demands

PRESSOVAC

SINGLE STAGE PUMPS

The Pressovac Vacuum Pump is frequently used for providing backing pressures for many types of mercury and oil diffusion pumps, for lecture demonstrations and for general laboratory applications where highest vacuums are not required. The Pressovac is a single stage, rotary type, oil-sealed pump operating on the principle of the eccentric rotor with spring-actuated moving vane. Air at atmospheric pressure is forced into a smaller volume by the action of an eccentric rotor with the moving vane always in contact, and is expelled from the exhaust port. The entire mechanism is completely immersed in oil. This insures a vacuum-tight seal of the stage, acts as a coolant and lubricates the moving parts. A built-in trap on one side of the housing prevents oil "back up" when the pump is stopped. A spray baffle in the top of the pump removes oil from the exhaust air. Other features include an easily accessible drain cock and a conveniently located sight-gage for a quick check of the oil level. The Pressovac is supplied with a one-piece intake nipple intended primarily for use with rubber tubing. Two basic models are available unmounted or mounted with a wide choice of motors. No. 90500 is a vacuum and pressure pump, No. 90540 is a vacuum pump only. All units are attractively finished in blue-gray enamel.

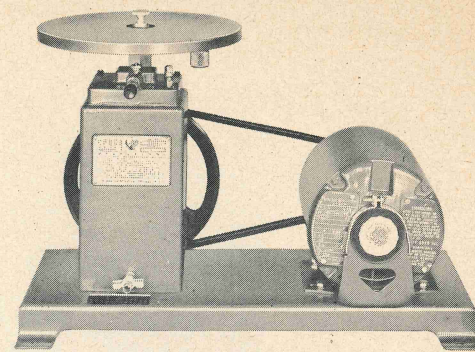
MOUNTED WITH MOTOR — VACUUM AND PRESSURE OR VACUUM ONLY — WITH OR WITHOUT PUMP PLATE

The mounted Pressovac Pump is supplied with a good quality 1/4 hp motor with grooved pulley, a No. 91131 molded rubber V-belt, 1 quart of No. 93050 Cenco-Hyvac Oil for the Vacuum Pressovac and No. 93055 Cenco-Hyvac Oil for the Vacuum and Pressure Pressovac, and a manual of complete operating instructions. All -1 through -8 pumps are supplied with a 3-wire line cord and plug with switch. All ac motors are single phase. A nickel-iron alloy pump plate with a precision ground top is available in two sizes — 9" diameter or 10" diameter. A threaded vent in the center of the plate is provided for attaching a No. 94515 nipple for rubber tubing connections. A valve is provided in the pump plate for admitting air into the system for easy removal of the bell jar.

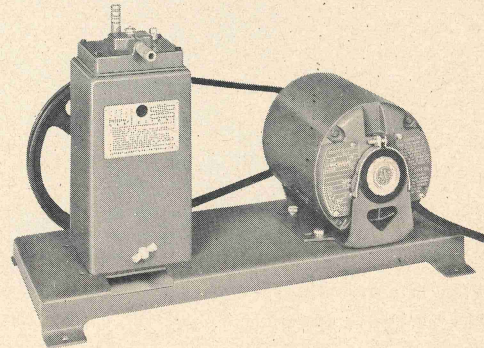
PUMP PLATES FOR PRESSOVACS

For replacement on or addition to Pressovac Pressure and Vacuum Pumps Nos. 90500, 90505, 90510, 90515, 90516.

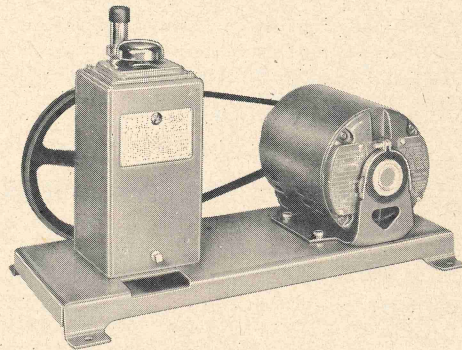
NO. 90520	9-Inch Pump Plate	\$41.00
NO. 90521	10-Inch Pump Plate	44.00



Vacuum and Pressure with Pump Plate



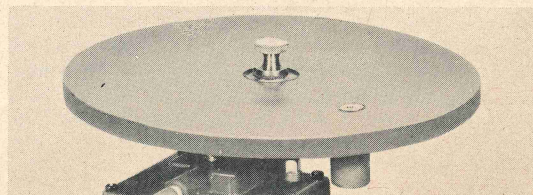
Vacuum and Pressure without Pump Plate



Vacuum Only

UNMOUNTED PUMP — VACUUM AND PRESSURE OR VACUUM ONLY — WITH OR WITHOUT PUMP PLATE

The unmounted Pressovac Pump is supplied with a grooved pulley. Four mounting holes, 1/4" diameter on 5 1/2" and 2-15/16" centers, are provided in the base of the pump. Also included is 1 quart of No. 93050 Cenco-Hyvac Oil for the Vacuum Pressovac and No. 93055 for Vacuum and Pressure Pressovac, and a manual of complete operating instructions. A nickel-iron alloy pump plate with a precision ground top, 9" diameter, is available. A threaded vent in the center of the plate is provided for attaching a No. 94515 nipple for rubber tubing connections. A valve is provided in the pump plate for admitting air into the system for easy removal of the bell jar. It is recommended that a 1/4 hp electric motor with grooved pulley and a V-belt be used. For best performance, the pump should be run at 600 rpm.



CENTRAL SCIENTIFIC COMPANY

SPECIFICATIONS

GUARANTEED VACUUM, millitorrs	15.0
GUARANTEED VACUUM with pump plate, millitorrs	25.0
FREE AIR CAPACITY	
Liters per minute	35
Cubic feet per minute	1.23
Normal operating speed, rpm	600
Oil required for one filling, quarts	1
Intake nipple, vacuum only, OD, inches	0.81
Intake nipple, vacuum and pressure, OD, inches	3/8
Motor, ac or dc, hp	1/4

DIMENSIONS WITH PUMP PLATE

Height, over-all, inches	12 1/2
Width, over-all, inches	10 1/2
Length, over-all, inches	20

DIMENSIONS WITHOUT PUMP PLATE

Height, over-all, inches	11 1/2
Width, over-all, inches	10 1/2
Length, over-all, inches	20

Net weight, unmounted, with pump plate, lbs.	34
Net weight, unmounted, without pump plate, lbs.	23
Net weight, mounted, with pump plate, lbs.	50
Net weight, mounted, without pump plate, lbs.	41

PRESSOVAC ORDERING GUIDE

CENCO NO.	MOTOR RATING	EACH
Vacuum and Pressure without Pump Plate		
90510-1	115 V, 60 cycle	\$110.00
90510-2	230 V, 60 cycle	113.75
90510-3	115 V, dc	160.50
90510-4	230 V, dc	155.00
90510-7	115 V, 50 cycle	119.00
90510-8	230 V, 50 cycle	119.00
90510-10	115 V, 60 cycle*	165.50
90510-23	Mounted without motor	82.25
90500	Unmounted pump only	77.50

Vacuum and Pressure with 9" Pump Plate

90515-1	115 V, 60 cycle	139.75
90515-2	230 V, 60 cycle	160.50
90515-3	115 V, dc	186.50
90515-4	230 V, dc	181.00
90515-5	115 V, 25 cycle	171.00
90515-7	115 V, 50 cycle	160.50
90515-8	230 V, 50 cycle	165.50
90505	Unmounted pump only	108.50

Vacuum and Pressure with 10" Pump Plate

90516-1	115 V, 60 cycle	145.00
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Vacuum Only without Pump Plate

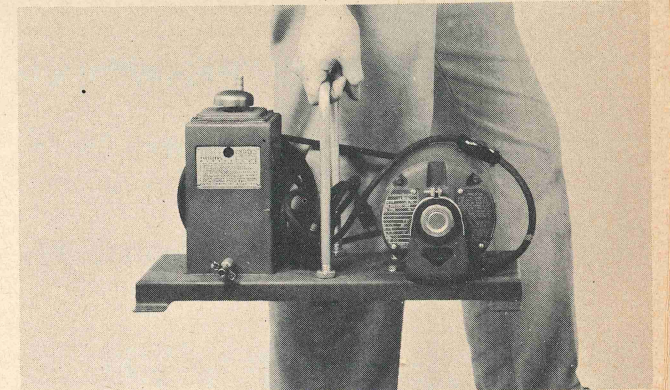
90550-1	115V, 60 cycle	\$110.00
90550-2	230V, 60 cycle	119.00
90550-8	230V, 50 cycle	119.00
90540	Unmounted pump only	82.25

Special motors are available on request		
NO. 91135	Belt Guard for above	\$14.75
NO. 91131	Replacement V-Belt for above	\$2.00
NO. 18204-6	3/16-Inch ID Rubber Tubing for vacuum and pressure pumps	\$1.05 per ft.
NO. 18204-11	1/16-Inch ID Rubber Tubing for vacuum only pumps	\$1.70 per ft.

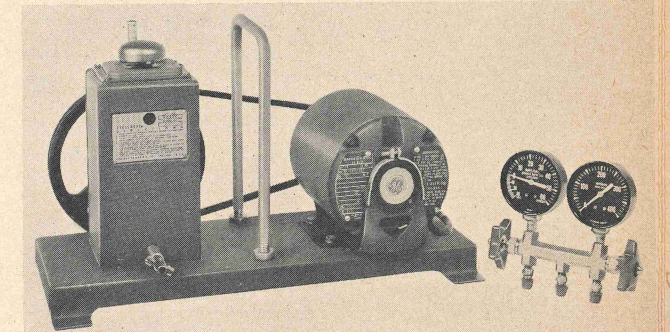
CENTRAL SCIENTIFIC COMPANY



PORTABLE PRESSOVAC



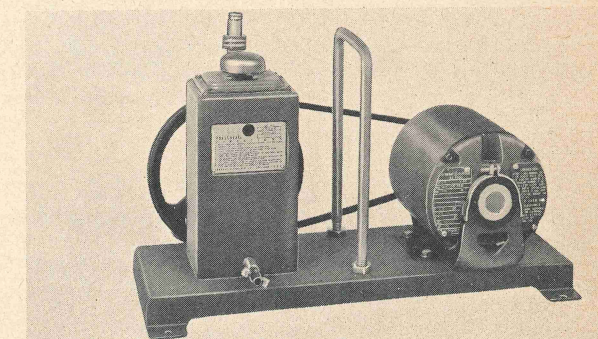
Designed primarily to evacuate and dehydrate refrigeration and air conditioning units. It weighs only 42 pounds and is easily transported from job to job. An ideal pump for many industrial applications that require moderate vacuum and portability. Basically, it is the Pressovac Vacuum Pump with a large nickel-plated, steel handle securely mounted to the base. Two models are available.



WITH MANIFOLD AND ONE-PIECE NIPPLE

Includes the Pressovac Vacuum Pump with a valve and gage manifold and a one-piece intake nipple for 5/8" ID rubber tubing. Available with a 1/4 hp, 115 volt, 60 cycle motor or without a motor. Both types include a carrying handle, 1 quart of No. 93050 Cenco-Hyvac Oil, and a complete operating manual.

NO. 90552-1	with 115 V, 60 cycle motor	\$124.95
NO. 90552-23	mounted without motor	107.50



WITH COUPLING FOR 3/8" COPPER TUBING

Includes the Pressovac Vacuum Pump with a coupling for 3/8 copper tubing. Available with a 115 volt, 60 cycle motor or without a motor. Both types include a carrying handle, 1 quart of No. 93050 Cenco-Hyvac Oil, and a complete operating manual.

NO. 90553-1	with 115 V, 60 cycle motor	\$117.50
NO. 90553-23	mounted without motor	99.50

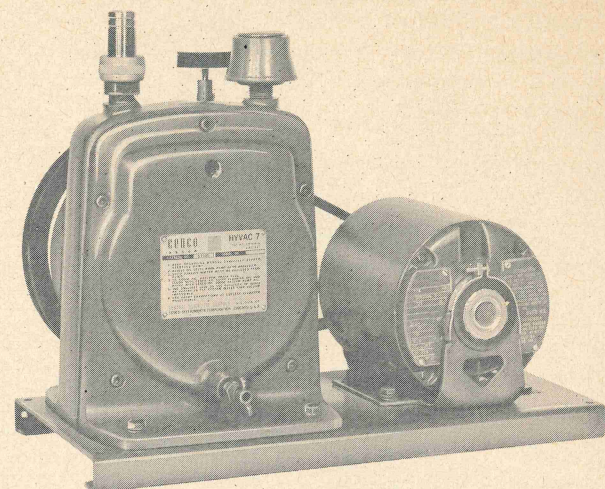
- Guaranteed vacuum to 10 microns of Hg (millitorrs)
- Free air capacity of 70 liters per minute
- Single stage, rotary, oil-sealed, mechanical pump
- Adjustable gas ballast

HYVAC 7

SINGLE STAGE PUMPS

The Hyvac Single Stage 7, the first in a new series of pumps, meets the need for a moderate-sized single stage pump for general vacuum use where the highest vacuum is not required. It can be used to back diffusion pumps or directly to pump down bell jars, vacuum ovens and furnaces, or for distillation operations. Like the other new pumps in the series, the Single Stage 7 is a rotary, oil-sealed pump operating on the principle of an eccentric rotor with a spring-loaded sliding vane. The entire working mechanism is immersed in oil to provide a vacuum-tight seal of the stage, act as a coolant, and lubricate the working parts. A built-in trap on one side of the housing prevents oil back-up when the pump is stopped and a spray baffle in the top of the housing removes oil from the exhaust air.

Other features include an adjustable gas ballast valve to expel condensible vapors and minimize contamination of the pump oil and a conveniently located sight-gage for a quick check of the oil level. Pumps are furnished with an intake nipple intended primarily for use with rubber tubing. Pumps are available mounted on a base with a wide choice of motors, mounted without a motor, or unmounted. All types are attractively finished in blue-grey enamel.



SPECIFICATIONS

GUARANTEED VACUUM, micron of Hg (millitorr)	10
FREE AIR CAPACITY	
Liters per minute	75
Cubic feet per minute	2.65
Normal operating speed, rpm	525
Oil required for one filling, pints	3 1/3
Intake nipple, OD, inches	0.83
Motor, hp	1/3
Height, over-all, inches	12 1/4
Length, over-all, inches	17 1/4
Width, over-all, inches	10 3/8
Net weight, mounted, lbs.	71

MOUNTED AND UNMOUNTED PUMPS

Mounted pumps are provided with a heavy metal base, a high quality 1/3 hp motor with grooved pulley, a molded rubber V-belt, 2 quarts of No. 93050 Cenco-Hyvac Oil, and a complete operating manual. Shipping weight is 94 lbs.

Unmounted pumps are provided with 2 quarts of No. 93050 Cenco-Hyvac Oil, a grooved pulley, and a complete operating manual. It is recommended that a 1/3 hp motor with grooved pulley and V-belt be used to operate the pump at 525 rpm. Four mounting holes, 3/8" in diameter and on 6" and 5 3/4" centers, are provided on the pump.

ORDERING GUIDE

CENCO NO.	MOTOR	RATING	EACH
91138-1	115/230 V, 60 cycle		\$198.00
91138-7	115/230 V, 50 cycle		206.25
91138-10	115/230 V, 60 cycle*		239.00
91138-18	220/440 V, 50/60 cycle, 3-phase		213.00
91138-23	Mounted without motor		159.00
91138-25	Unmounted pump only		145.00
Special motors are available on request			*explosion proof
NO. 91708	Belt Guard for above		\$15.50
NO. 91132-7	Replacement V-Belt for above		\$1.80
NO. 18204-8	5/8-Inch ID Rubber Tubing for above		\$1.50 per ft.



CENTRAL SCIENTIFIC COMPANY

- Guaranteed vacuum to 5 microns of Hg (millitorrs)
- Free air capacity of 140 liters per minute
- Single stage, rotary, oil-sealed, mechanical pump
- Adjustable gas ballast

HYVAC 14

SINGLE STAGE PUMPS

SPECIFICATIONS

GUARANTEED VACUUM, microns of Hg (millitorrs)	5
FREE AIR CAPACITY	
Liters per minute	140
Cubic feet per minute	4.94
Normal operating speed, rpm	525
Oil required for one filling, pints	4
Intake nipple, OD, inches	1.31
Motor, hp	1/3
Height, over-all, inches	15 1/8
Length, over-all, inches	17 7/8
Width, over-all, inches	11 5/8
Net weight, mounted, lbs.	94

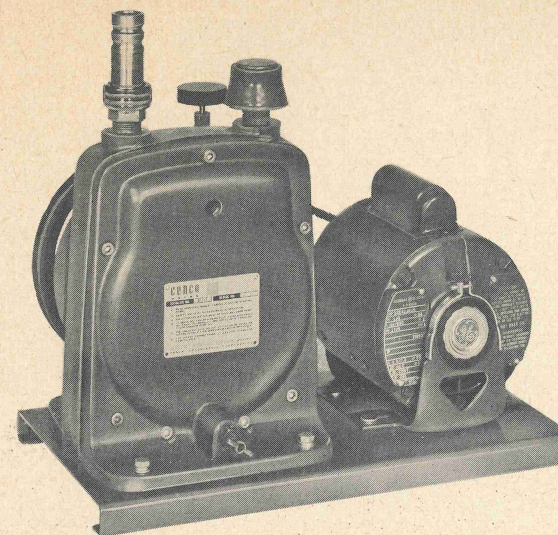
MOUNTED AND UNMOUNTED PUMPS

Mounted pumps are provided with a heavy metal base, a high quality 1/3 hp motor with grooved pulley, a molded rubber V-belt, 2 quarts of No. 93050 Cenco-Hyvac Oil, and a complete operating manual. Shipping weight is 94 lbs.

Unmounted pumps are provided with 2 quarts of No. 93050 Cenco-Hyvac Oil, a grooved pulley, and a complete operating manual. It is recommended that a 1/3 hp electric motor with grooved pulley and V-belt be used to operate the pump at 525 rpm. Four mounting holes, 3/8" in diameter and on 7" and 6" centers, are provided on the pump.

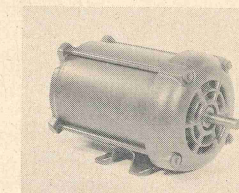
ORDERING GUIDE

CENCO NO.	MOTOR	RATING	EACH
91140-1	115/230 V, 60 cycle		\$240.00
91140-7	115/230 V, 50 cycle		254.00
91140-10	115/230 V, 60 cycle*		277.50
91140-18	220/440 V, 50/60 cycle, 3-phase		249.00
91140-23	Mounted without motor		195.00
91140-25	Unmounted pump only		170.00
Special motors are available on request			*explosion proof
NO. 91708	Belt Guard for above		\$15.50
NO. 91132-14	Replacement V-Belt for above		\$2.35
NO. 18205-12	1-Inch ID Rubber Tubing for above		\$2.05 per ft.

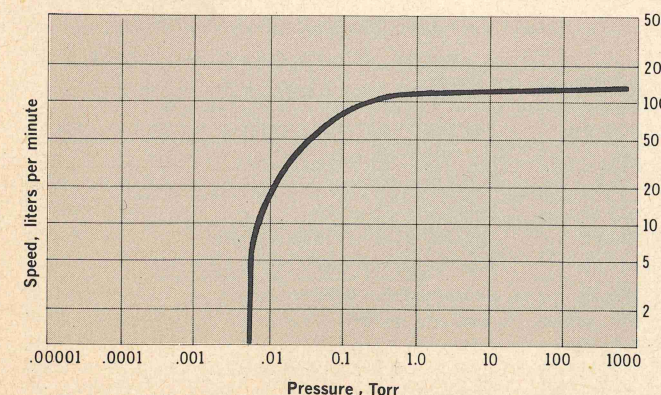


The Hyvac 14 Single Stage Pump is a useful sized pump for general vacuum work in pilot plants, research laboratories or industrial plants in applications where the highest vacuum is not required. It can also be used to back a diffusion pump in many applications. Based upon the proven Hyvac Two-Stage design, the Single Stage 14 is a rotary, oil-sealed pump operating on the principle of an eccentric rotor with a spring-loaded, sliding vane. The entire working mechanism is immersed in oil to provide a vacuum tight seal of the stage, act as a coolant, and lubricate the working parts. A built-in trap on one side of the housing prevents oil "back-up" when the pump is stopped and a spray baffle in the top of the housing removes oil from the exhaust air. Other features include an adjustable gas ballast valve to expel condensible vapors and minimize contamination of the pump oil and a conveniently located sight-gage for a quick check of the oil level. Pumps are furnished with an intake nipple intended primarily for use with rubber tubing. Pumps are available mounted on a base with a wide choice of motors, mounted without a motor, or unmounted. All types are attractively finished in blue-grey enamel.

All models of Cenco vacuum pumps are available with EXPLOSION PROOF MOTORS.



SPEED-PRESSURE CURVE



CENTRAL SCIENTIFIC COMPANY



- Guaranteed vacuum to 10 microns of Hg (millitorrs)
- Free air capacity of 70 liters per minute
- Single stage, rotary, oil-sealed, mechanical pump
- Adjustable gas ballast

HYVAC 7

SINGLE STAGE PUMPS

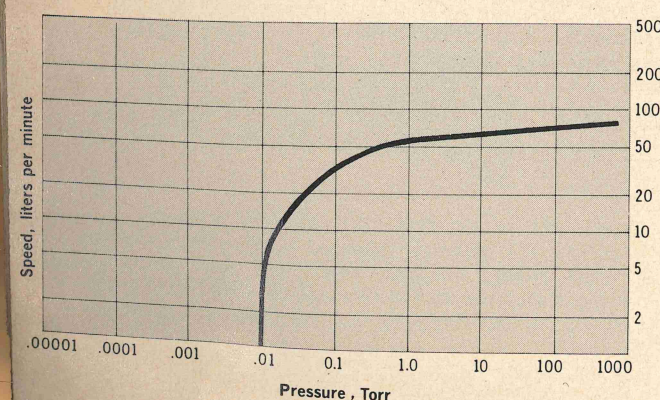
The Hyvac Single Stage 7, the first in a new series of pumps, meets the need for a moderate-sized single stage pump for general vacuum use where the highest vacuum is not required. It can be used to back diffusion pumps or directly to pump down bell jars, vacuum ovens and furnaces, or for distillation operations. Like the other new pumps in the series, the Single Stage 7 is a rotary, oil-sealed pump operating on the principle of an eccentric rotor with a spring-loaded sliding vane. The entire working mechanism is immersed in oil to provide a vacuum-tight seal of the stage, act as a coolant, and lubricate the working parts. A built-in trap on one side of the housing prevents oil back-up when the pump is stopped and a spray baffle in the top of the housing removes oil from the exhaust air.

Other features include an adjustable gas ballast valve to expel condensible vapors and minimize contamination of the pump oil and a conveniently located sight-gage for a quick check of the oil level. Pumps are furnished with an intake nipple intended primarily for use with rubber tubing. Pumps are available mounted on a base with a wide choice of motors, mounted without a motor, or unmounted. All types are attractively finished in blue-grey enamel.



Cenco vacuum pumps are also available unmounted.

SPEED-PRESSURE CURVE



ORDERING GUIDE

CENCO NO.	MOTOR	RATING	EACH
91138-1	115/230 V, 60 cycle		\$198.00
91138-7	115/230 V, 50 cycle		206.25
91138-10	115/230 V, 60 cycle*		239.00
91138-18	220/440 V, 50/60 cycle, 3-phase		213.00
91138-23	Mounted without motor		159.00
91138-25	Unmounted pump only		145.00
Special motors are available on request			*explosion proof
NO. 91708	Belt Guard for above		\$15.50
NO. 91132-7	Replacement V-Belt for above		\$1.80
NO. 18204-8	5/8-Inch ID Rubber Tubing for above		\$1.50 per ft.



CENTRAL SCIENTIFIC COMPANY

- Guaranteed vacuum to 5 microns of Hg (millitorrs)
- Free air capacity of 140 liters per minute
- Single stage, rotary, oil-sealed, mechanical pump
- Adjustable gas ballast

HYVAC 14

SINGLE STAGE PUMPS

SPECIFICATIONS

GUARANTEED VACUUM, microns of Hg (millitorrs)	5
FREE AIR CAPACITY	
Liters per minute	140
Cubic feet per minute	4.94
Normal operating speed, rpm	525
Oil required for one filling, pints	4
Intake nipple, OD, inches	1.31
Motor, hp	1/3
Height, over-all, inches	15 1/8
Length, over-all, inches	17 7/8
Width, over-all, inches	11 5/8
Net weight, mounted, lbs.	94

MOUNTED AND UNMOUNTED PUMPS

Mounted pumps are provided with a heavy metal base, a high quality 1/3 hp motor with grooved pulley, a molded rubber V-belt, 2 quarts of No. 93050 Cenco-Hyvac Oil, and a complete operating manual. Shipping weight is 94 lbs.

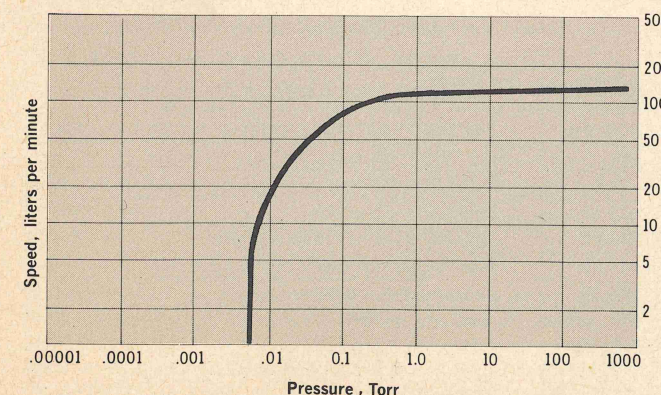
Unmounted pumps are provided with 2 quarts of No. 93050 Cenco-Hyvac Oil, a grooved pulley, and a complete operating manual. It is recommended that a 1/3 hp electric motor with grooved pulley and V-belt be used to operate the pump at 525 rpm. Four mounting holes, 3/8" in diameter and on 7" and 6" centers, are provided on the pump.

ORDERING GUIDE

CENCO NO.	MOTOR	RATING	EACH
91140-1	115/230 V, 60 cycle		\$240.00
91140-7	115/230 V, 50 cycle		254.00
91140-10	115/230 V, 60 cycle*		277.50
91140-18	220/440 V, 50/60 cycle, 3-phase		249.00
91140-23	Mounted without motor		195.00
91140-25	Unmounted pump only		170.00
Special motors are available on request			*explosion proof
NO. 91708	Belt Guard for above		\$15.50
NO. 91132-14	Replacement V-Belt for above		\$2.35
NO. 18205-12	1-Inch ID Rubber Tubing for above		\$2.05 per ft.

All models of Cenco vacuum pumps are available with EXPLOSION PROOF MOTORS.

SPEED-PRESSURE CURVE



CENTRAL SCIENTIFIC COMPANY



- Guaranteed vacuum to 5 microns of Hg (millitorrs)
- Free air capacity of 280 liters per minute
- Single stage, rotary, oil-sealed, mechanical pump
- Adjustable gas ballast

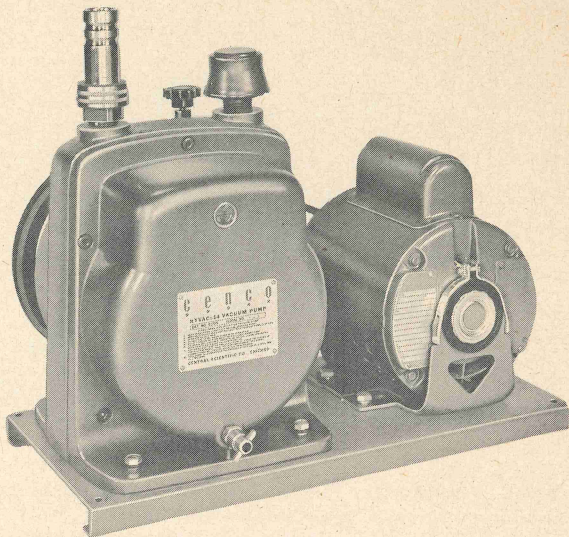
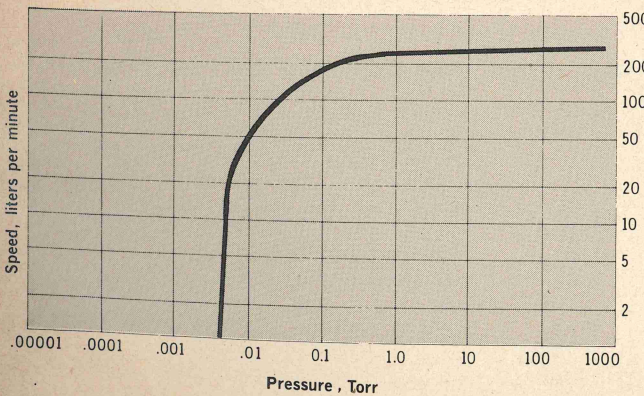
HYVAC 28

SINGLE STAGE PUMPS

The Hyvac 28 Single Stage Pump is the largest of a new series of Cenco mechanical pumps. Offering a capacity of 280 liters per minute and an ultimate vacuum of 5 microns, the Single Stage 28 is useful for general work where the highest vacuum is not required or for backing diffusion pumps in vacuum systems. Like the other Cenco Single Stage Pumps, it is based on the proven Hyvac Two-Stage design and is a rotary, oil-sealed pump operating on the principle of an eccentric rotor with a spring-loaded, sliding vane. The entire working mechanism is immersed in oil to provide a vacuum tight seal of the stage, act as a coolant, and lubricate the working parts. A built-in trap on one side of the housing prevents oil "back-up" when the pump is stopped and a spray baffle in the top of the housing removes oil from the exhaust air.

Other features include an adjustable gas ballast to expel condensible vapors and minimize contamination of the pump oil and a conveniently located sight-gage for a quick check of the oil level. Pumps are furnished with an intake nipple intended primarily for use with rubber tubing. Pumps are available mounted on a base with a wide choice of motor types, mounted without a motor, or unmounted. All units are attractively finished in blue-grey enamel.

SPEED-PRESSURE CURVE



SPECIFICATIONS

GUARANTEED VACUUM, microns of Hg (millitorrs)	5
FREE AIR CAPACITY	
Liters per minute	280
Cubic feet per minute	
Normal operating speed, rpm	525
Oil required for one filling, pints	5
Intake nipple, OD, inches	1.31
Motor, hp	1/2
Height, over-all, inches	15 1/8
Length, over-all, inches	17 7/8
Width, over-all, inches	12 3/4
Net weight, mounted, lbs.	119

MOUNTED AND UNMOUNTED PUMPS

Mounted pumps are provided with a heavy metal base, a high quality 1/2 hp motor with grooved pulley, a molded rubber V-belt, 2 quarts of No. 93050 Cenco-Hyvac Oil, and a complete operating manual. Shipping weight is 119 lbs.

Unmounted pumps are provided with 2 quarts of No. 93050 Cenco-Hyvac Oil, a grooved pulley, and a complete operating manual. It is recommended that a 1/3 hp electric motor with grooved pulley and V-belt be used to operate the pump at 525 rpm. Four mounting holes, 3/8" in diameter and on 7" and 6" centers, are provided on the pump.

ORDERING GUIDE

CENCO NO.	MOTOR	RATING	EACH
91142-1	115/230 V, 60 cycle		\$425.00
91142-7	115/230 V, 50 cycle		445.00
91142-10	115/230 V, 60 cycle*		485.00
91142-18	220/440 V, 50/60 cycle, 3-phase		440.00
91142-23	Mounted without motor		375.00
91142-25	Unmounted pump only		350.00
Special motors are available on request *explosion proof			
NO. 91708	Belt Guard for above		\$15.50
NO. 91132-14	Replacement V-Belt for above		\$2.35
NO. 18205-12	1-Inch ID Rubber Tubing for above		\$2.05 per ft.



CENTRAL SCIENTIFIC COMPANY

MECHANICAL PUMP OILS

The development of Cenco-Hyvac Oil is the result of exhaustive tests made in the Cenco laboratories. The oil incorporates two essential high vacuum characteristics: A low vapor pressure which does not materially increase at temperatures up to 50° C., and a viscosity sufficiently low for use at 15° C. that remains fairly constant up to 50° C. This oil should always be used to achieve the guaranteed performance of Cenco oil-sealed pumps.

LIGHT GRADE, CENCO-HYVAC VACUUM PUMP OIL

Size 2 is supplied in a plastic container, sizes 3 and 4 in metal cans.

CENCO NO.	SIZE	CASE QUANTITY	EACH
93050-2	1 quart	12	\$0.75
93050-3	1 gallon	6	2.25
93050-4	5 gallons	6	9.50

HEAVY GRADE, CENCO-HYVAC VACUUM PUMP OIL

This oil has a greater viscosity and is for use in Nos. 90500, 90505, 90510 and 90515 Pressovacs and the Hypervac 100 vacuum pumps. Size 2 is supplied in plastic containers, sizes 3 and 4 in metal cans.

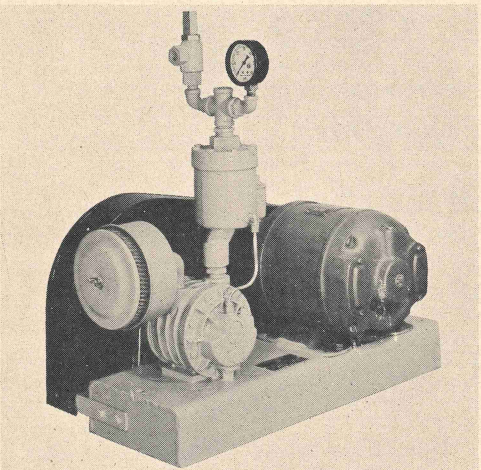
CENCO NO.	SIZE	CASE QUANTITY	EACH
93055-2	1 quart	12	\$ 0.80
93055-3	1 gallon	6	2.50
93055-4	5 gallons	6	10.35



CENCO-HYVAC VACUUM PUMP FLUSHING OIL

Swift, safe removal of harmful sediment and contamination from high vacuum pumps is accomplished by the use of this specially developed oil. One or two flushings cleans most pumps of the accumulated residues. This not only protects the pump but considerably improves high vacuum production. The pump can be re-filled with operating oil immediately after flushing. Cenco-Hyvac flushing oil is for flushing only and should not be used for high vacuum operation.

CENCO NO.	SIZE	CASE QUANTITY	EACH
93060-1	1 quart	12	\$0.80
93060-2	1 gallon	4	2.25



AIR COOLED BLOWER AND VACUUM PUMP UNIT

SPECIFICATIONS

CAPACITY, cfm	4.3
Max. pressure — continuous duty, lbs.	10
Max. pressure — intermittent duty, lbs.	25
Max. vacuum — continuous duty, inches	15
Max. vacuum — intermittent duty, inches	28.5

MOUNTED WITH MOTOR

The mounted unit is supplied with a high quality 1/2 hp motor, grooved pulley, a molded rubber V-belt and complete operating instructions.

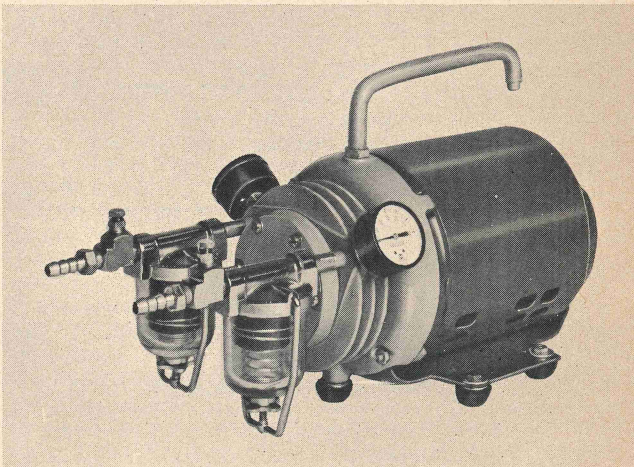
No. 93960-1, 115/230 volt, 60 cycle \$398.00

MOUNTED WITHOUT MOTOR

The blower and vacuum pump are mounted on an iron base with outboard bearing, oil cup and V-groove pulley for direct motor drives. It is recommended that a 1/2 hp motor run at 625 rpm be used for best performance.

No. 93965-1 \$156.00

BLOWER AND VACUUM UNITS



CENCO PORTABLE BLOWER AND VACUUM UNIT

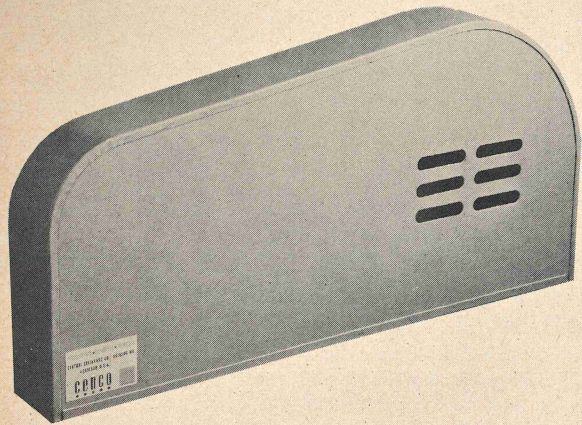
Simplicity of design and engineering have resulted in a compact, portable vacuum/pressure unit that employs only 5 moving parts. A rotor and four nonmetallic vanes insure smooth, quiet operation. Ideal for glass blowing and suction for filtration in gravimetric analysis. A combination filter-oiler mounted on the intake port filters incoming air and introduces minute droplets of oil which are carried by the air stream into the pumping chamber. An exhaust filter attached to the pressure outlet port removes oil vapors and serves as an efficient noise muffler. Available with or without vacuum and pressure gages. Supplied with connectors for 3/16" I.D. rubber hose, a 6-foot line cord with plug and an on-off motor switch. Non-additive No. 93050 Oil is recommended for use in the oiler-filter. Two models are available with a choice of voltages.

No. 93971-1, 115 volt, 60 cycle	\$71.50
No. 93971-8, 230 volt, 50 cycle	85.00
No. 93972-1, with gages, 115 volt, 60 cycle	78.75
No. 93972-8, with gages, 230 volt, 50 cycle	99.75



CENTRAL SCIENTIFIC COMPANY

ACCESSORIES FOR MECHANICAL PUMPS



BELT GUARDS

Protect personnel and protect the vacuum pump from damage caused by objects becoming entangled in the belt or pulley. Cenco Belt Guards are made of sheet steel. They enclose the transmission belt, motor pulley and pump pulley. Each guard is ready for mounting on the pump bases. Various sizes are listed to fit individual pumps. Attractively finished in blue-grey enamel.

CENCO BELT GUARD NO.	FOR CENCO PUMPS	EACH
91135	91105 Hyvac 90510 Pressovac 90515 Pressovac 90550 Pressovac	\$14.75
91508	91305 Hyvac 2	15.50
91708	91506 Hyvac 7 92003 Megavac 91705 Hyvac 14 91905 Hyvac 28* 91955 Hyvac 45*	15.50
93022	93020 Hypervac 25 93006 Hypervac 23	25.00

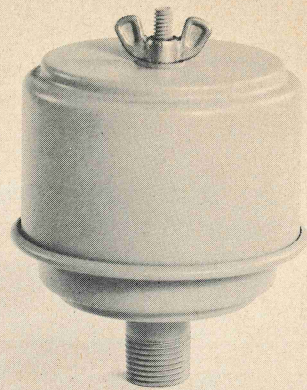
*No belt guard available for pumps with explosion proof motors.

V-BELTS

For best performance of a Cenco High Vacuum Pump, it is important that the proper V-belt be used for power transmission. The belts listed on this page have been carefully selected for use with specified pumps.

BELT NO.	EACH	FOR USE WITH CENCO PUMPS
91131	\$ 2.00	Nos. 90500, 90505, 90510, 90515, 90540, 90550, 90552 and 90553 Pressovacs; Nos. 91100 and 91105 Hyvacs; Nos. 93265, 93275 Pump Outfits.
91132-2	1.80	Nos. 91300, 91305 and 91306 Hyvac 2
91132-7	1.80	Nos. 91500, 91502, 91505 and 91506 Hyvac 7
91132-14	2.35	Nos. 91700 and 91705 Hyvac 14; Nos. 91900 and 91905 Hyvac 28; Nos. 91950 and 91955 Hyvac 45
92006	2.00	Nos. 92001 and 92003 Megavac
92020	2.60	Nos. 93001 and 93006 Hypervac 23; Nos. 93010 and 93020 Hypervac 25
92046	2.00	Nos. 92040 and 92045 Hypervac 4
93035*	18.75	No. 93033 Hypervac 100

*No. 93035 belts are supplied in sets of three. When ordering for replacement, it is advisable to order a complete set in order to assure uniform tension and life.



EXHAUST FILTERS

Easy to install and long lasting, these filters trap oil vapors and oil droplets which may be exhausted from mechanical pumps. The filter consists of several layers of a non-organic fiber. Oil which is separated from the air at the pump exhaust port is drained back into the pump. Available in four sizes to fit most Cenco Vacuum Pumps.

CENCO NO.	INLET CONNEC-TION	CAPACITY CFM	FOR USE WITH	EACH
93126-1	1/2" IPS	5	Hyvac 2* Hyvac 7 (Single or Two-Stage) Megavac	\$31.40
93126-2	3/4" IPS	10	Hyvac 14 (Single or Two-Stage)	32.65
93126-3	1 1/2" IPS	20	Hyvac 28 (Two-Stage only) Hyvac 45	36.25
93126-4	3" IPS	100	Hyvac 150	54.45

*Requires No. 93122 Adapter

FILTER ELEMENTS

Replacable filter elements for the No. 93121 Exhaust Filters listed above.

CAT. NO.	FITS FILTER NO.	EACH
93127-1	93126-1	\$ 8.15
93127-2	93126-2	8.80
93127-3	93126-3	10.25
93127-4	93126-4	18.35

EXHAUST FILTER ADAPTER

To connect No. 93121-1 Exhaust Filter to the Hyvac 2 vacuum pump.
No. 93122 \$1.20

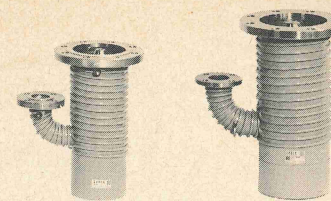
AIR PURIFIER FILTER

For use with Nos. 90500 or 93971 Pumps for the removal of small amounts of moisture, oil, dirt and sediment from the air stream and for equalizing the flow of air to produce a steady stream without pulsations. It is designed to be used on the pressure side of the pump. Air pressure should not be greater than 100 lbs. per square inch. The dispersion rate is 20 cubic feet per minute. The filter is so effective in removing oil vapors, that the filtered air carries no trace of oil odor after a week's operation. The filter should be replaced after 240 hours of continuous operation, at which time it will be found to be filled with moisture, oil and dirt removed from the pumped air.

The filter consists of a metal cylinder containing highly activated carbon, specially treated rayons and baffle plates, with connections at each end for 1/4" pipe. A 1/4" to 1/8" reducer and a 1/8" close nipple are required for connection to the Pressovac pump.

No. 93975 \$4.00

DIFFUSION PUMPS



Oil diffusion pumps remain the basic tool for high volume vacuum technology and have become increasingly effective through the use of new, low vapor pressure oils.

In recent years the search for liquids with low vapor pressures at ambient temperatures has led to the use of a series of silicone and organic oils, uniquely suited to the demands of oil diffusion pumps and the systems they are designed to evacuate. In addition to their low vapor pressures, these new oils possess thermal stability, that is, they are not easily decomposed when exposed to air at operating temperatures. They also resist decomposition when pumping chemically reactive gases.

Oils with these properties have improved high speed diffusion pumps. Often refrigerated traps and their associated apparatus can be eliminated.

In this section are listed a number of pumps capable of using these oils. Some of the pumps effect self-purification of the pumping fluid even when reactive vapors are being handled and some have extremely high pumping speeds, others utilize air cooling.

Oil diffusion pumps require a suitable mechanical "fore-pump" to reduce the system pressure to the point where the diffusion pump can "take-hold". This is approximately 100 millitorrs. Subsequently, the fore-pump must maintain the pressure in the exhaust port of the diffusion pump below its fore-pressure tolerance. The fore-pressure tolerance is a function of the design of the diffusion pump, and the amount of gas passing through the system.

A discussion of the selection of the proper fore-pump appears in the paragraph entitled "Selection of Backing Pump". Parenthetically it should be noted that it is necessary to avoid opening the diffusion pump to atmosphere while the oil is still hot; the oil would become contaminated, its vapor pressure would increase, and this new, higher pressure would be the ultimate attainable pressure.

BAFFLES

The ultimate pressure attained in the high vacuum end of the diffusion pump is equal to the saturated vapor pressure of the pump fluid at ambient temperature. Low vapor pressure oils, therefore, are important.

Further, there is inevitable diffusion of hot oil vapor in the direction of the system being evacuated. This "back-streaming" can be prevented by introducing one or two bends in the connection between the diffusion pump and the system, or by the insertion of a suitable baffle. Care must be exercised in applying these bends or baffles, because the same labyrinthine passages which prevent the back-streaming of oil vapor, decrease the effective speed of the pump. In a closed system this generally is not important, but if large gas flows are to be handled, careful consideration must be given to baffling.

The oil diffusion pump, fitted with a bend or baffle, provides a high vacuum saturated with oil vapor. The pressure of this vapor at room temperature will be about 3×10^{-7} mm Hg (.0003 millitorr) for DC-704 silicone oil, or 5×10^{-10} mm Hg (.0000003 millitorr) for CONVALEX 10. Clearly this confirms the importance of low vapor pressure fluids in attaining not only the highest vacuum, but in constructing systems containing the minimum amount of oil vapor or fluid.

Because the vapor pressure of the oil is only a function of the temperature (and, of course, the type of oil), a cold trap, or a refrigerated trap using dry ice or liquid air, inserted between the diffusion pump and the system, will interpose a high vacuum region saturated with oil vapor at a lower than ambient temperature which means a lower vapor pressure. The ultimate of the system is now the vapor pressure of the oil vapor at this lower temperature.

APPLICATIONS

Oil diffusion pumps are used in a multitude of applications, some of which are

1. Vacuum casting of metals to eliminate occluded gases and hence porosity.
2. Insulating electronic components and transformers. "Potting" under vacuum, insures gas-free, dense insulation.
3. Vacuum dehydration of blood plasma, foods, drugs at necessary low temperatures.
4. Coating of lenses with magnesium fluoride.
5. Metalizing of plastics and metals.
6. Molecular distillation of organic materials.
7. Evacuation of electron tubes.
8. Production of vacuum environmental chambers for space vehicle studies.

SELECTION OF BACKING PUMP

Because, for a given flow of gas through a vacuum system, the pumping speed of the backing pump determines the fore-pressure against which the diffusion pump operates, it is a simple matter to match the rotary backing pump to the diffusion pump using the basic relationship between flow, pressure and pump speed. This is

$$Q = PS$$

where Q is gas flow in millitorr-liters per second, P is the pressure at the pump intake in millitorr, and S is the pump speed in liters per second. Q frequently is called "throughput".

In a vacuum system, if the speed of the diffusion pump is known (from the manufacturer's rating) together with the pressure on the high vacuum side, the flow Q through the system is determined by the above equation. It is also possible that a calibrated leak might produce the given flow Q, or the flow Q might be the result of the known outgassing rate of the materials and area of the system.

Regardless of the source of the flow Q, its value, once known, permits the elements of the pumping system to be proportioned properly. Suppose, for example, that a diffusion pump has a speed of 200 liters per second and that the pressure in the vacuum system it is exhausting is 1 millitorr; clearly the throughput Q for this system is fixed and must be constant at any point in the system. It is 200 liters per second times 1 millitorr and this is 200 millitorr-liters per second.

Diffusion pumps are rated as to speed and fore-pressure tolerance; the latter is the maximum pressure against which the pump will work.

Suppose in this example, the fore-pressure tolerance is 300 millitorr (by the manufacturer's rating). While the diffusion pump theoretically could operate into a fore-line at this pressure, no margin for gas bursts or pressure fluctuation is allowed. Also, low fore-pressures minimize "back-streaming." Hence it is wise to take a fraction of this fore-pressure tolerance, say 1/10 to 1/4, as a realistic fore-pressure which the backing pump must produce at the diffusion pump exhaust. In this case the fore-pressure into which the diffusion pump works is, say, 30 millitorr.

Using the first equation for the fore-pump section of the system, it can be seen that the speed of the mechanical pump must be

$$S = \frac{Q}{P} = \frac{200 \text{ millitorr-liters/sec.}}{30 \text{ millitorr}} = 6.65 \text{ liters/second}$$

If, on the other hand, it was known that the throughput of the system was much less, say 20 millitorr-liters per second (the pressure in the high vacuum system might be 0.1 millitorr rather than 1 millitorr) and all other factors remained the same, the speed of the mechanical pump would be

$$S = \frac{Q}{P} = \frac{20 \text{ millitorr-liters/sec.}}{30 \text{ millitorr}} = .665 \text{ liters/sec.} \\ = 40 \text{ liters/min.}$$

It should be understood that if the pump-down time of a vacuum system is important, it is not sufficient to size the mechanical pump simply to the diffusion pump. For this kind of a situation, see the section on Planning a Vacuum System.

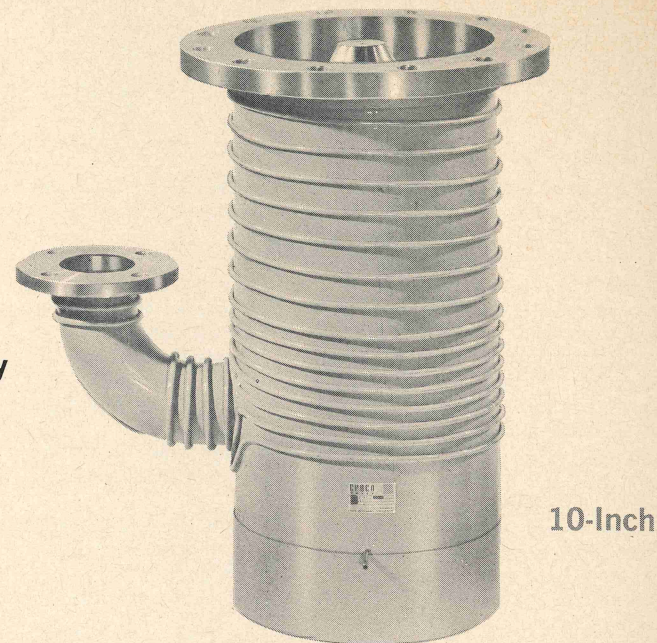


CENTRAL SCIENTIFIC COMPANY



CENTRAL SCIENTIFIC COMPANY

- Three modern design models
- Highest pumping speeds
- Superior jet configuration
- Unique internal heater for greater efficiency
- Stainless steel or carbon steel models



10-Inch

CENCO OIL DIFFUSION PUMPS

Backed by Cenco's long experience in the high vacuum field, here are three new diffusion pumps incorporating exclusive features that make them faster pumping than any other commercially available pumps of their size. This superior pumping speed, coupled with other features, makes Cenco Diffusion Pumps an excellent choice for such high vacuum applications as space chamber evacuation, coating of lenses, thin film deposition, evaporation, and reducing pressure in cyclotron tubes.

One of the most important features of Cenco Diffusion Pumps is the all-stainless steel jet that incorporates a superior type of configuration that aids in producing the high pumping speed. At the same time, the stainless steel construction eliminates the corrosion often encountered with conventional aluminum jets while reducing outgassing to a minimum. Another unique Cenco feature is the internal heater. Made of glass-insulated Nichrome ribbon and located inside the boiler rather than wrapped around it, this type of heater provides faster heat-up time with absolute minimum breakdown of pumping fluid.

Pumps are available with either stainless steel bodies and flanges for maximum service or with more moderately priced carbon steel bodies and flanges.

Both stainless steel and carbon steel models are furnished complete as described with stainless steel jets but without pumping fluid, powerstat or forepump. For complete dimensional details and specifications, refer to the tables on these pages.

ORDERING GUIDE

CENCO NO.	TYPE AND SIZES	EACH
93405	Stainless Steel 4-Inch Pump	\$ 395.00
93406	Carbon Steel 4-Inch Pump	360.00
93410	Stainless Steel 6-Inch Pump	535.00
93411	Carbon Steel 6-Inch Pump	465.00
93415	Stainless Steel 10-Inch Pump	1400.00
93416	Carbon Steel 10-Inch Pump	1250.00

CONSTRUCTION

Jet assemblies are constructed from stainless steel to eliminate corrosion and reduce out-gassing to a minimum. The heater, located inside the boiler for direct contact with the pump oil, is made from glass insulated Nichrome ribbon. The boiler itself is formed from stainless steel. Bodies are available in a choice of stainless steel for maximum service or in carbon steel. Both types are finished in baked-on enamel.

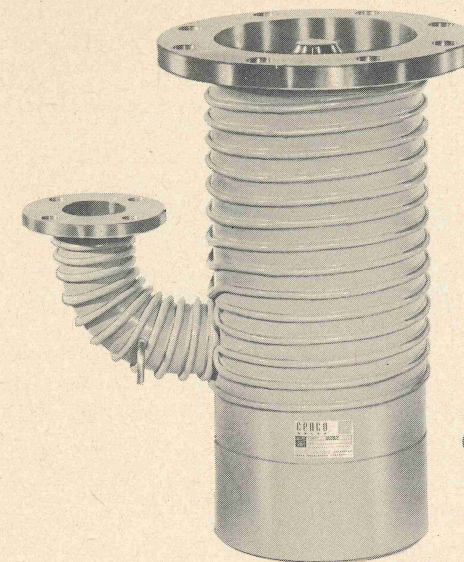
The inlet and outlet flanges on all models are smoothly finished, flat A.S.A. type. For connections to the high vacuum (intake) flange, a Cenco captive "O" ring seal is supplied.

OPERATING SPECIFICATIONS	4-Inch Pump	6-Inch Pump	10-Inch Pump
MAXIMUM PUMPING SPEED, liters per second	1000	2000	4500
OPERATING PRESSURE, torr (mm of Hg)	From 2×10^{-3} to less than 1×10^{-9}		
LIMITING FOREPRESSURE, torr			
At full load	0.65	0.50	0.45
At no load	0.80	0.70	0.60
PUMP FLUID			
Recommended type	DC704, DC705 or similar types		
Quantity, cc	285	550	1600
COOLING WATER REQUIREMENTS, gallons per min. at 20°C	0.25	0.40	0.75
HEATER			
Voltage	115	115	230
Wattage	1200	1800	3500
FOREPUMP REQUIREMENTS, Cubic ft. per minute	5	10	20
RECOMMENDED FOREPUMP	HYVAC 14	HYVAC 28	HYVAC 150

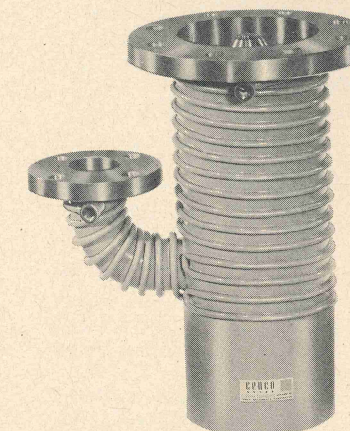


CENTRAL SCIENTIFIC COMPANY

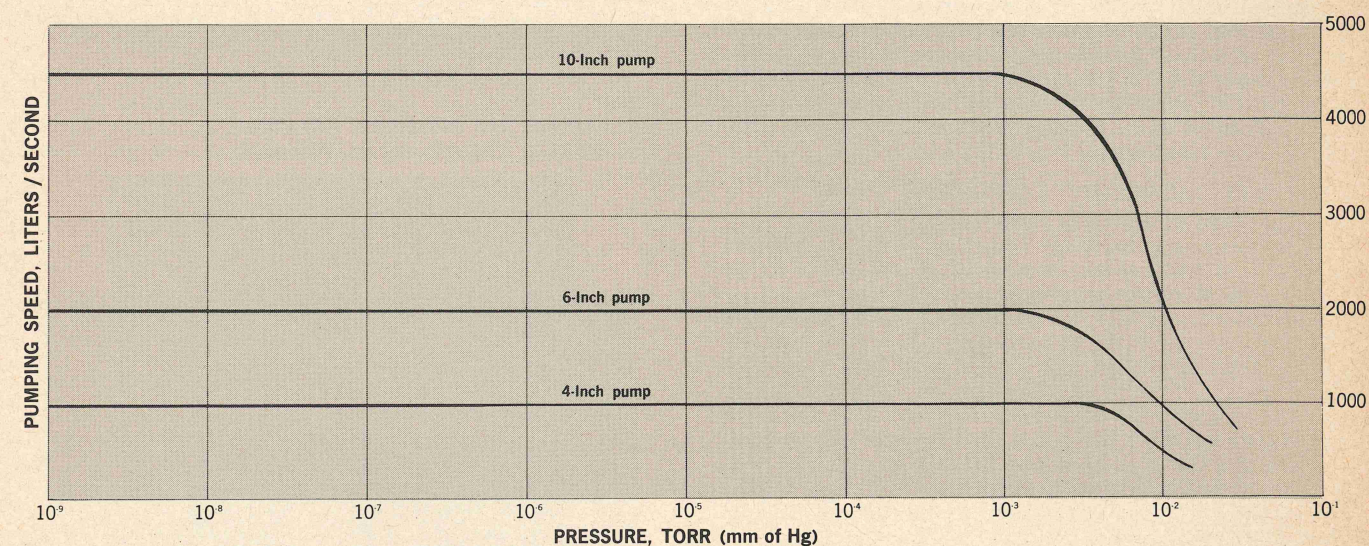
Faster pumping than any other pumps of their size



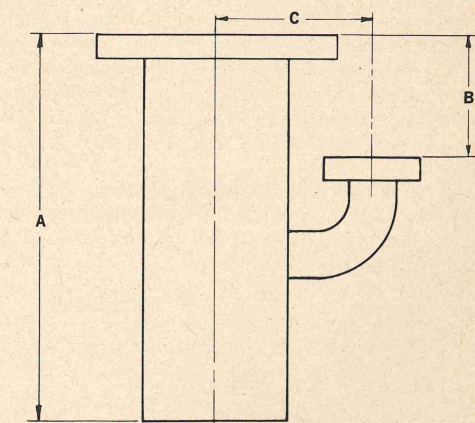
6-Inch



4-Inch



DIMENSIONAL SPECIFICATIONS	4-Inch Pump	6-Inch Pump	10-Inch Pump
INLET CONNECTION			
Type	Flange	Flange	Flange
O.D., inches	9	11	16
I.D., inches	$5\frac{1}{4}$	7	$11\frac{1}{4}$
Thickness, inches	$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{1}{2}$
Bolt circle, inches	$7\frac{1}{2}$	$9\frac{1}{2}$	$14\frac{1}{2}$
Number of holes	8	8	12
Hole diameter, inches	$\frac{3}{4}$	$\frac{7}{8}$	1
OUTLET CONNECTION			
Type	Flange	Flange	Flange
O.D., inches	5	6	7
I.D., inches	1.68	2.44	2.64
Thickness, inches	$\frac{5}{8}$	$1\frac{1}{8}$	$1\frac{3}{8}$
Bolt circle, inches	$3\frac{3}{8}$	$4\frac{3}{4}$	$5\frac{1}{2}$
Number of holes	4	4	4
Hole diameter, inches	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$
COOLING CONNECTIONS, inch	$\frac{1}{4}$ FPT	$\frac{1}{4}$ FPT	$\frac{1}{4}$ FPT



DRAWING DIMENSIONS	4-Inch	6-Inch	10-Inch
A, inches	$14\frac{1}{8}$	$16\frac{1}{2}$	$23\frac{3}{8}$
B, inches	$4\frac{3}{8}$	$5\frac{1}{4}$	$10\frac{5}{8}$
C, inches	6	$7\frac{7}{8}$	$10\frac{5}{8}$

CENTRAL SCIENTIFIC COMPANY



SUPERVAC OD-25 OIL DIFFUSION PUMP

For high speed evacuation. The entire unit consists of only three basic parts: the jet manifold, the jacket, and the boiler with detachable 175 watt electric heater. The jacket and boiler compartments are held together by six Allen-head cap screws. By simply loosening the screws, these three units come apart for inspection, draining, cleaning and filling. A synthetic rubber "O" ring assures a vacuum-tight seal. The jet manifold, which is a three stage unit of welded steel, fits snugly in the boiler compartment and is easily removed for cleaning. It is completely enclosed by the jacket which may be made a permanent part of the vacuum system. The jacket contains the necessary couplings for making all connections to the pump from the high vacuum system, the fore-pressure pump and the water supply for cooling. The boiler compartment contains the jet manifold and holds the diffusion pump oil.

The pump uses a 50 gms. charge of a purified organic pump oil such as No. 93261 Cencoil-B which will produce an ultimate pressure of 5×10^{-7} torr untrapped. Trapped it will produce an ultimate of 1×10^{-7} torr. For lower ultimate pressures, the pump uses No. 93256 Octoil-S with a boiling point of 143.5°C . For producing lowest ultimate pressures with maximum stability the Silicone oils DC-702 or DC-704 are recommended. No. 93262 DC-702 Silicone oil has a boiling point of 160°C at 10^{-2} torr pressure, and No. 93264 DC-703 Silicone oil has a boiling point of 185°C at 10^{-2} torr pressure.

The pump is attached at the vacuum system by means of No. 94235 Cenco "O" ring connectors with the result that it may be disconnected or reconnected in a few minutes. All parts are of cold rolled steel except the brass couplings and the copper cooling coil. The exterior finish is copper and nickel plated, and the inside is copper plated to prevent rusting. The couplings are white nickel plated. Five rubber "O" rings, for use with the pump, are supplied. Vacuum intake coupling is No. 94235-6; outlet is No. 94235-3; water couplings are No. 94235-1.

ALL-STEEL MERCURY DIFFUSION PUMP

For high speed exhaustion of vacuum systems to very low pressures. A speed of approximately 7 liters per second at pressures of the order of 10^{-6} torr may be attained. Higher speeds are attainable if the maximum opening of the pump is used.

Of umbrella type design, the pump is constructed entirely of steel to eliminate possibility of breakage and to provide high efficiency of heat transmission. The vapor conduit, with the detachable umbrella, can readily be removed so that the pump may be thoroughly cleaned when this becomes necessary. If its maximum speed is not required, a No. 93202 Steel Reducer may be used, by means of which connection may be made to a smaller tube. The diameter of the large pump intake is about 63 mm and that of the reducer is 24 mm. Connection to the pump is made by means of No. 94222 Tape.

An electric heater is required, and the No. 93210 Cone Type Heater is recommended. For easily supporting the pump, No. 93205-2 Clamp is available. Any one of the Cenco high vacuum pumps furnishing a fore-pressure of 10-15 millitorrs may be used as a backing pump. The larger sizes should be used in order to reach, as quickly as possible, pressures at which the diffusion pump operates. Requires about 300 g of CP mercury for operation.

No. 93201 Vacuum Pump, Mercury Diffusion Type, All Steel, Cenco-Supervac with steel strip for connection and directions for operation, but without mercury, vacuum sealing tape, reducer, heater or clamp.

No. 93201 \$72.50

CLAMP

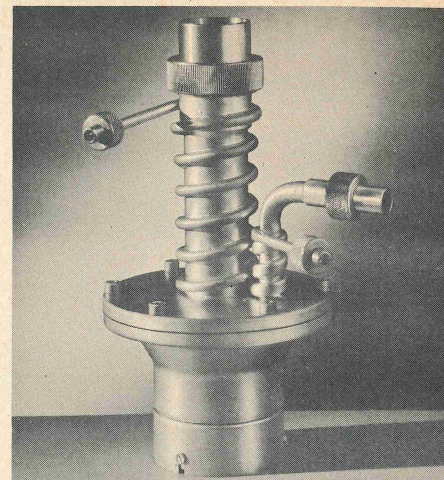
For supporting No. 93201 Mercury Diffusion Pump on a 19 mm rod.

No. 93205-2 \$19.50

CENCO CONE TYPE ELECTRIC HEATER

Designed especially for use with No. 93201 Mercury Diffusion Pump for most effective and economical operation. Power consumption is 250 watts.

No. 93210-3, 115 volt ac/dc \$26.00



Fluid charge, 50 gms. Coolant (Water 10 to 20°F below room temperature) $60-80^{\circ}\text{F}$. Rate of flow of coolant, 0.1 gal./min. Fore-pressure, 100 millitorrs. Pump speed at 10^{-4} torr is 28 liters per second.

No. 93330-1, 115 volt ac/dc \$150.00
No. 93330-2, 230 volt ac/dc 150.00

RUBBER "O" RING

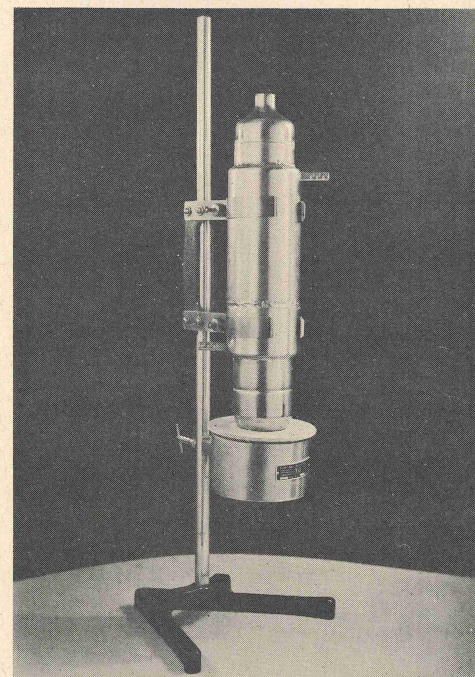
For use on the boiler flange of No. 93330-1 or -2 Supervac OD-25 Diffusion Pump.

No. 93332, package of 12 \$8.40

DISK HEATER

For use on No. 93330-1 and -2 Supervac OD-25 Diffusion Pump.

No. 93334-1, 115 volt ac/dc, 175 watts \$13.00
No. 93334-2, 230 volt, ac/dc, 175 watts 13.00



SPUN STEEL REDUCER

For use with No. 93201 Mercury Diffusion Pump for connection to tubes of 24 mm diameter.

No. 93202 \$3.85

CENCO MERCURY

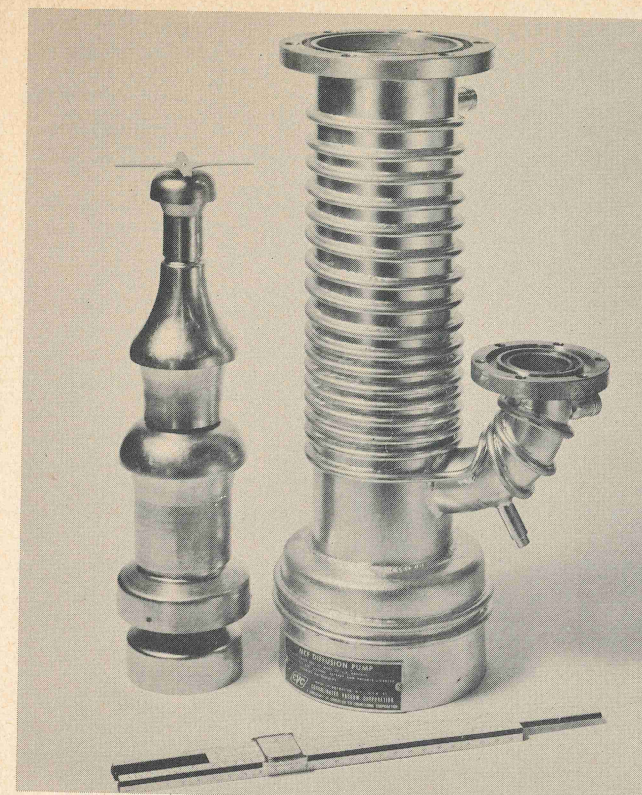
C.P., ACS Triple distilled quicksilver.

1 pound \$12.60
5 pounds 56.50
4 ounces 4.50

15 pounds maximum quantity for parcel post shipment.

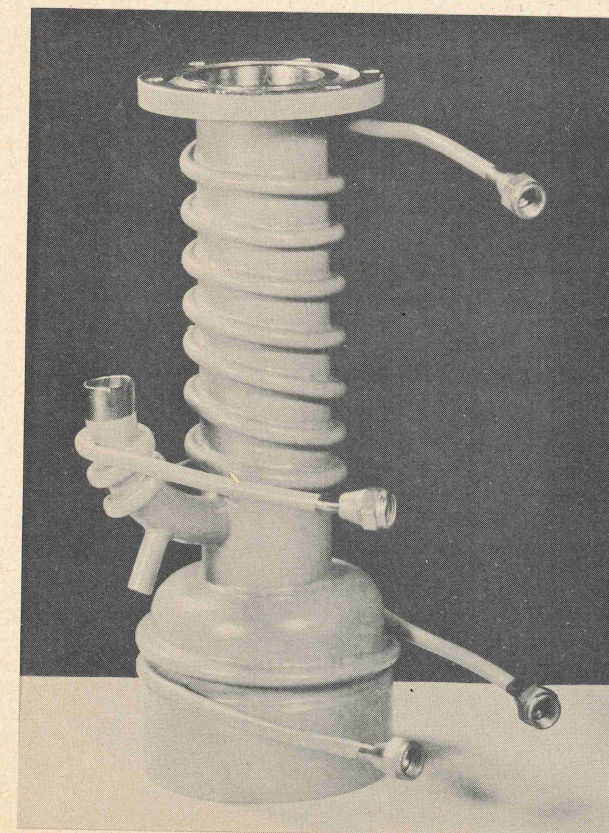


CENTRAL SCIENTIFIC COMPANY



OUTLET FLANGE

O.D., inches	$3\frac{3}{4}$
I.D., inches	$1\frac{1}{4}$
Thickness, inches	$\frac{1}{2}$
Bolt circle, inches	$3\frac{5}{16}$
Number of holes	6
Hole diameter, inches	$\frac{9}{32}$



ALL-METAL DIFFUSION PUMP, CVC TYPE MCF-300

This is a water-cooled, fractionating diffusion pump featuring enlarged boilers and extra heater capacity achieving pressures of 5×10^{-7} torr without cold baffles or traps. A bright coating of non-flaking nickel, chemically deposited, on the jet assemblies prevents rust and reduces heat loss by radiation. Jet assemblies can be easily removed for cleaning and maintenance. By making the liquid in the boiler travel over the longest possible route between compartments, fractionation and self-purification are performed with high efficiency. The standard pump is equipped with water cooling coils. A few turns of copper tubing are also wound around the boiler to permit exposure to the atmosphere. When the pump is to be operated on a line of greater voltage than the normal operating voltage, a variable transformer should be provided to control the heater input. The heater is external and can be easily replaced when necessary. It is recommended that Convoil-20, DC-704, Octoil or an equivalent pump fluid be used for best performance. Supplied with complete operating instructions but without forepump, powerstat or pump fluid.

NO. 93246 \$305.00

SPECIFICATIONS

PUMPING SPEED, liters per second	300
OPERATING PRESSURE, torr	2.5×10^{-7} to 2×10^{-3}
LIMITING FOREPRESSURE, torr	
At full load	0.22
At no load	0.30
PUMP FLUID, quantity, cc	225
HEATER	
Voltage	115
Wattage	750
COOLING CONNECTIONS, inch	$\frac{1}{4}$ NPT

INLET FLANGE

O.D., inches	6
I.D., inches	$3\frac{3}{8}$
Thickness, inches	$\frac{1}{2}$
Bolt circle, inches	$5\frac{1}{4}$
Number of holes	6
Hole diameter, inches	$\frac{7}{16}$

ALL-METAL DIFFUSION PUMP, CVC TYPE MCF-60

This water-cooled fractionating diffusion pump attains an ultimate pressure of 5×10^{-7} torr without cold baffles or traps. Highest fractionation efficiency has been achieved by making the liquid in the boiler travel over the longest possible path between compartments. External cooling coils on the boiler provide rapid cool-down in valveless systems. It is recommended that Convoil-20, DC-704, Octoil or an equivalent pump fluid be used for best performance. Supplied with complete instructions but without forepump, powerstat or pump fluid.

NO. 93244 \$160.00

SPECIFICATIONS

PUMPING SPEED, liters per second	60
OPERATING PRESSURE, torr	2×10^{-7} to 3×10^{-3}
LIMITING FOREPRESSURE, torr	
At full load	0.12
At no load	0.25
PUMP FLUID, quantity, cc	100
HEATER	
Voltage	115
Wattage	400
COOLING CONNECTIONS, inch	$\frac{1}{8}$ NPT

INLET FLANGE

O.D., inches	$3\frac{3}{8}$
I.D., inches	$1\frac{7}{8}$
Thickness, inches	$\frac{3}{8}$
Bolt circle, inches	$3\frac{1}{16}$
Number of holes	6
Hole diameter, inches	$\frac{9}{32}$

OUTLET TUBING

O.D., inches	$\frac{3}{4}$
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CENTRAL SCIENTIFIC COMPANY



**ALL-METAL DIFFUSION PUMP,
CVC TYPE MC-275**

This water-cooled, non-fractionating diffusion pump achieves an ultimate pressure of 8×10^{-7} torr. An aluminum jet assembly is enclosed in a seamless steel case. The MC-275 utilizes an internal heater and has a separate cooling coil on the boiler. It is recommended that Convoil-20, Octoil or an equivalent pump fluid be used for best performance. Supplied with complete operating instructions but without forepump, powerstat, gasket or pump fluid.

NO. 93245-1**\$196.00****SPECIFICATIONS**

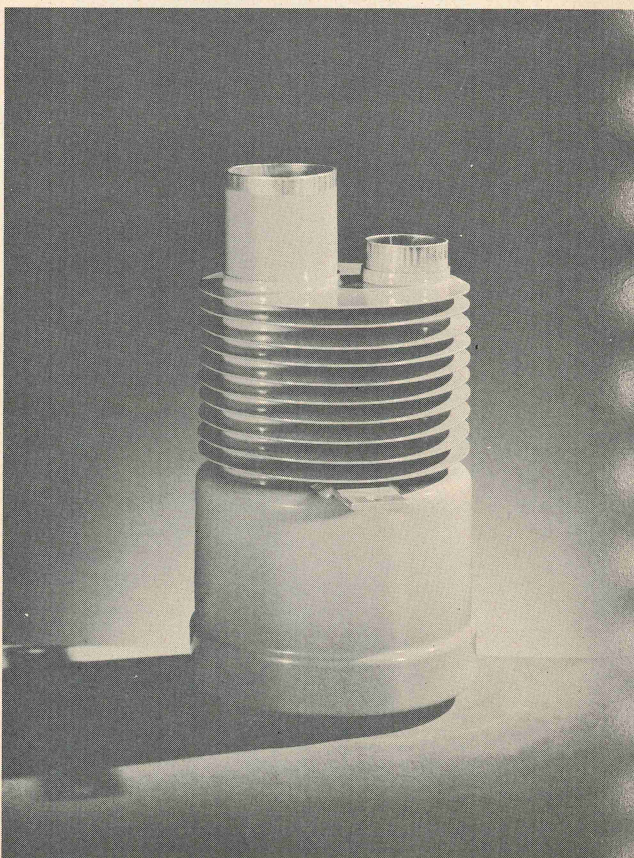
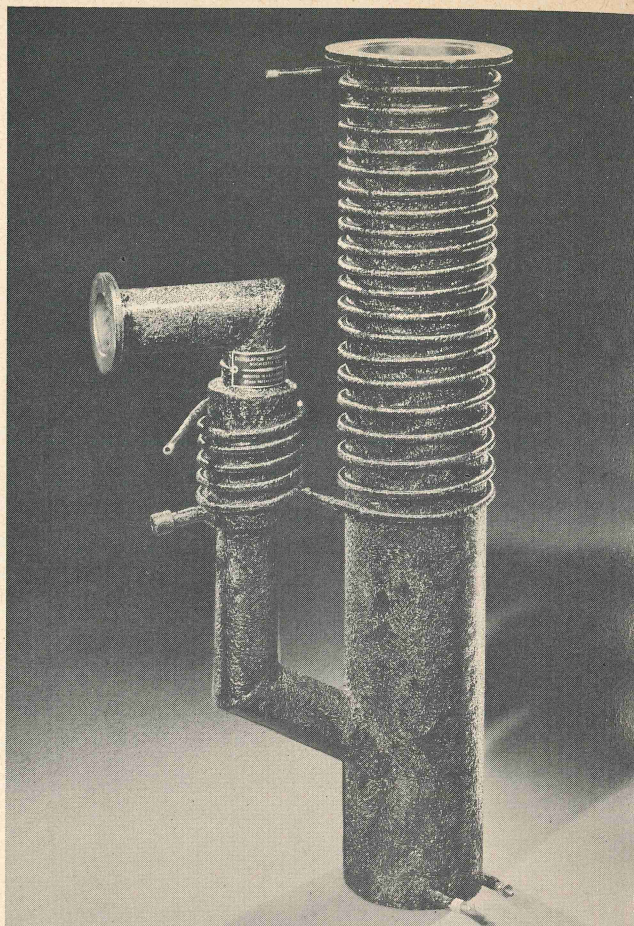
PUMPING SPEED, liters per second	208
OPERATING PRESSURE, torr	8×10^{-7} to 2×10^{-3}
LIMITING FOREPRESSURE, torr	
At full load	0.09
At no load	0.15
PUMP FLUID, quantity, cc	200
HEATER	
Voltage	115
Wattage	400
COOLING CONNECTIONS, inch	$\frac{1}{4}$ NPT
INLET FLANGE	
O.D., inches	6
I.D., inches	$3\frac{3}{8}$
Thickness, inches	$\frac{1}{2}$
Bolt circle, inches	$5\frac{1}{4}$
Number of holes	6
Hole diameter, inches	$\frac{7}{16}$
OUTLET FLANGE	
O.D., inches	$3\frac{3}{4}$
I.D., inches	$1\frac{11}{16}$
Thickness, inches	$\frac{3}{8}$
Bolt circle, inches	$3\frac{3}{8}$
Number of holes	6
Hole diameter, inches	$\frac{9}{32}$

**ALL-METAL DIFFUSION PUMPS,
CVC TYPE VMF-10 AND -11**

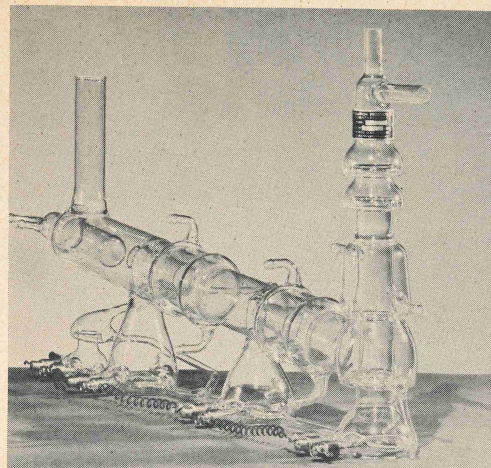
These small fractionating diffusion pumps are for use in the laboratory or in vacuum systems of moderate size where an inexpensive and compact unit is desired. The four pumps in this series produce an ultimate pressure of 1×10^{-6} torr and have limiting forepressures of 1 to 2×10^{-1} torr. Baffles are provided in the inlet arm to reduce backstreaming of pump fluid vapors into the system. Each VMF pump is supplied with mounting brackets and reducing adapters for the inlet and outlet connections. Available in air-cooled models with cooling fins or water-cooled models with cooling coils. It is recommended that Octoil, DC-704 or an equivalent pump fluid be used for best performance. Supplied with complete instructions but without forepump, powerstat or pump fluid.

NO. 93247-3, air-cooled VMF-10**\$102.00****NO. 93247-33, water-cooled VMF-11****102.00****SPECIFICATIONS**

PUMPING SPEED, liters per second	10.5
OPERATING PRESSURE, torr	1.2×10^{-6} to 2×10^{-3}
LIMITING FOREPRESSURE, torr	
At full load	0.095
At no load	0.16
PUMP FLUID, quantity, cc	55
HEATER	
Voltage	115
Wattage	135
COOLING CONNECTIONS, inch (VMF-11)	$\frac{1}{4}$ tube
INLET TUBING	
O.D., inches	$1\frac{1}{2}$
OUTLET TUBING	
O.D., inches	$1\frac{1}{8}$



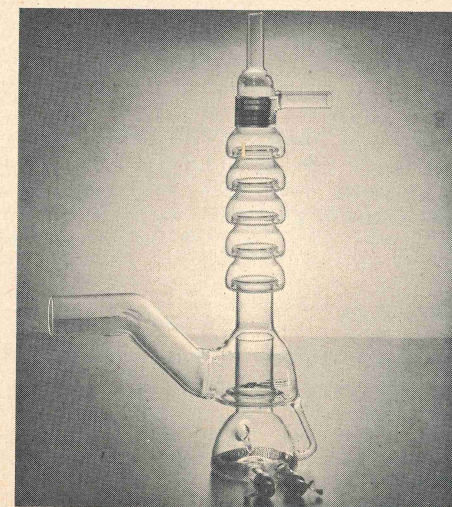
CENTRAL SCIENTIFIC COMPANY

GLASS DIFFUSION PUMPS**ALL-GLASS, THREE-STAGE DIFFUSION PUMP,
CVC TYPES GF-25 AND -26**

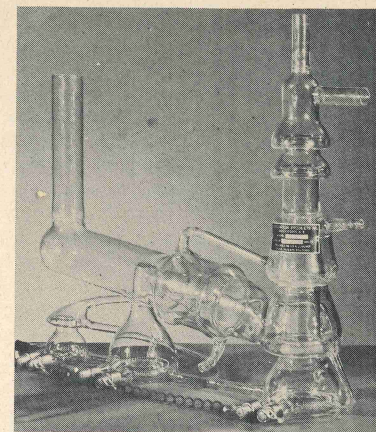
The GF-25 (water-cooled) and GF-26 (air cooled) are three-stage, fractionating pumps constructed entirely of Pyrex brand glass. The pumps have three jets, catchment lobes and four boiling compartments. Side tubes are provided for draining the uppermost lobe and connecting a gage for measuring the forepressure. Each of the boiling compartments contain heating coils with terminals sealed through the glass and are proportioned for proper heating when connected in series. With careful adjustment of heater input and cooling, and after baking out the system, a pressure of 8×10^{-8} torr at 25°C can be obtained without the use of a cold trap. A cold trap will extend the ultimate pressure into the 10^{-9} torr region. Both pumps are rated at a maximum speed of 29 liters per second with a limiting forepressure of 0.12 torr. It is recommended that Octoil-S, Octoil or an equivalent pump fluid be used for best performance. Supplied with complete operating instructions but without forepump, powerstat or pump fluid.

NO. 93235-1, air-cooled GF-26**\$290.00****NO. 93235-2, water-cooled GF-25****385.00****SPECIFICATIONS**

PUMPING SPEED, liters per second	26
OPERATING PRESSURE, torr	8×10^{-7} to 2×10^{-3}
LIMITING FOREPRESSURE, torr	
At full load	0.075
At no load	0.12
PUMP FLUID, quantity, cc	130
HEATER	
Voltage	115
Wattage	264
INLET CONNECTION, O.D., mm	32
OUTLET CONNECTION, O.D., mm	15



CENTRAL SCIENTIFIC COMPANY

**ALL-GLASS, TWO-STAGE DIFFUSION PUMP,
CVC TYPE GF-20**

The GF-20 is a two-stage, water-cooled fractionating pump constructed entirely of Pyrex brand glass. Attains pressures of 8×10^{-7} torr. The pump has two jets, catchment lobes and three boiling compartments. A side tube is provided on the outlet tube for connection of a gage for measuring the fore-pressure. Three heating coils, one in each compartment, are proportioned for proper heating when connected in series. It is recommended that Octoil, Octoil-S or an equivalent pump fluid be used for best performance. Supplied with complete operating instructions but without forepump, powerstat or pump fluid.

NO. 93230-2**\$251.00****SPECIFICATIONS**

PUMPING SPEED, liters per second	29
OPERATING PRESSURE, torr	8×10^{-8} to 9×10^{-4}
LIMITING FOREPRESSURE, torr	
At full load	0.075
At no load	0.12
PUMP FLUID, quantity, cc	200
HEATER	
Voltage	115
Wattage	248
INLET CONNECTION, O.D., mm	32
OUTLET CONNECTION, O.D., mm	15

**ALL-GLASS, SINGLE-STAGE DIFFUSION PUMP,
CVC TYPE G-4**

The G-4 is a single-stage, semi-fractionating, air-cooled pump constructed entirely of Pyrex brand glass. A single jet and a series of catchment lobes are located in the vertical outlet tube above the jet. A small drain tube is provided for emptying the uppermost lobe after long periods of operating, particularly if volatiles are being handled. This tube may be sealed off permanently. Pressures of 5×10^{-6} torr are attainable when the G-4 is used in an all-glass system. This pump has a maximum speed of 9 liters per second with a limiting forepressure of 0.04 torr. It is recommended that Octoil, Octoil-S or an equivalent pump fluid be used for best performance. Supplied with complete instructions but without forepump, powerstat or pump fluid.

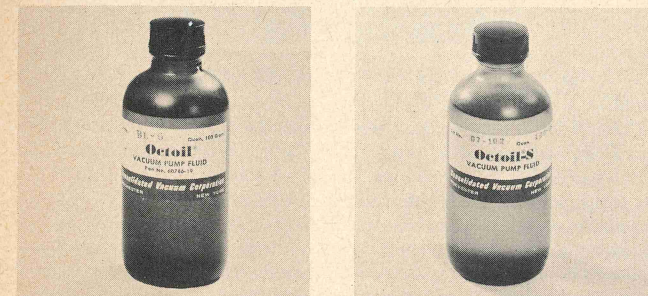
NO. 93225**\$75.00****SPECIFICATIONS**

PUMPING SPEED, liters per second	8
OPERATING PRESSURE, torr	7×10^{-6} to 2×10^{-3}
LIMITING FOREPRESSURE, torr	
At full load	0.04
At no load	0.04
PUMP FLUID, quantity, cc	65
HEATER	
Voltage	115
Wattage	50
INLET CONNECTION, O.D., mm	32
OUTLET CONNECTION, O.D., mm	15

DIFFUSION PUMP OILS

Selection of the organic fluid to be used with diffusion pumps should be carefully considered. Low vapor pressure oils have been recommended with each pump. For lowest obtainable pressures the use of Cencoil-B or Octoil-S is suggested. Diffusion pump oils of these types should be changed when the volatile fractions have finally boiled off. This will occur in about two months of continuous operation. The only indication of a necessity for oil change will be the failure to attain proper ultimate pressures.

Silicone fluids, recently developed for use with diffusion pumps, are highly recommended for producing an exceptionally high ultimate vacuum with maximum stability. The semi-inorganic structure of silicone fluids results in an inherent heat stability which permits high vacuum systems to be opened to the air without decomposition or reduction of pumping speed.



OCTOIL DIFFUSION PUMP OIL

CENCO NO.	SIZE	EACH
93254-1	100 grams	\$ 6.15
93254-2	500 grams	18.90

OCTOIL-S DIFFUSION PUMP OIL

Especially purified 2-ethylhexylsebecate having a boiling point of 143.5° C. at 10⁻² torr* pressure.

CENCO NO.	SIZE	EACH
93256-1	100 grams	\$ 6.95
93265-2	500 grams	22.40

BUTYL PHTHALATE DIFFUSION PUMP OIL

Purified for use in diffusion pumps. Boiling point 85° C. at 10⁻² torr* pressure.

No. 93258-2, 500 grams \$5.25



CENCOIL-B DIFFUSION PUMP OIL

A purified organic oil that produces a vacuum of better than 5 x 10⁻⁷ torr* untrapped.

CENCO NO.	SIZE	EACH
93261-1	100 grams	\$ 4.25
93261-2	500 grams	17.00



SILICONE, DC 702, DIFFUSION PUMP OIL

For producing an exceptionally high ultimate vacuum with maximum stability in diffusion pumps. The semi-inorganic structure of silicone fluids results in an inherent heat stability which permits high vacuum systems to be opened to the air without decomposition or reduction of pumping speed. It eliminates the fouling of boiler surfaces even in electron microscopes, vacuum tube evacuators and metal evaporator systems which are frequently opened to air. Operating temperatures, 175° to 250° C. Boiling point at 10⁻² torr*, 160° C.

CENCO NO.	SIZE	EACH
93262-1	50 ml	\$ 3.20
93262-2	100 ml	6.00
93262-3	200 ml	11.00
93262-4	500 ml	17.70

SILICONE, DC 704, DIFFUSION PUMP OIL

A silicone pump fluid capable of producing a vacuum in the range of 10⁻⁶ to 10⁻⁸ torr*. Chemically inert, non-toxic, free of impurities and resistant to gamma radiation. Color, water white; Viscosity at 35° C., 39 centistoke; Flash Point, 410° F.; Specific Gravity at 25° C., 1.07; Boiling Point, 185° C. with forepressures of 5 to 10 torr.

CENCO NO.	SIZE	EACH
93264-1	50 ml	\$ 3.75
93264-2	100 ml	7.00
93264-3	200 ml	12.50
93264-4	500 ml	20.30

SILICONE, DC 705, DIFFUSION PUMP OIL

A silicone diffusion pump fluid designed to produce ultra-high vacuum. Without refrigeration, vacua ranging from 5 x 10⁻⁹ to 2 x 10⁻¹⁰ torr* are being attained consistently. When freon-refrigerated baffles (at -35° C.) or zeolite traps are used, pressures of 5 x 10⁻¹¹ torr, or lower, are obtainable. Chemically inert, non-toxic and free of impurities. DC 705 can be degassed and evaporated without cracking. The jets stay free of tars and hard carbon. Oxidation resistant, it eliminates need for cooling the pump before releasing vacuum. Allows quick pumpdown even after exposure to air at operating temperatures. Color, water white to light straw; Viscosity at 25° C., 170 Centistokes; Flash Point, 470° F.; Specific Gravity, 1.095; Boiling Point, 245° C. at 0.5 torr.

No. 93263-4, 500 cc \$38.00

CONVALEX 10 DIFFUSION PUMP OIL

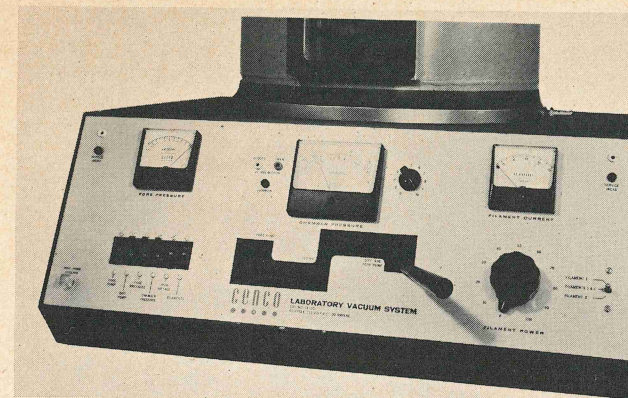
An extremely low vapor pressure diffusion pump fluid, attaining vacua of 10⁻⁹ and 10⁻¹⁰ Torr*. Color, straw-yellow; Boiling point, 300°C at 1 Torr; Viscosity at 100°C; 13 centistokes; Flash point, 288°C; Fire point, 350°C; Specific gravity at 20°C, 1.2. No. 93257, 100 gram bottle \$18.50



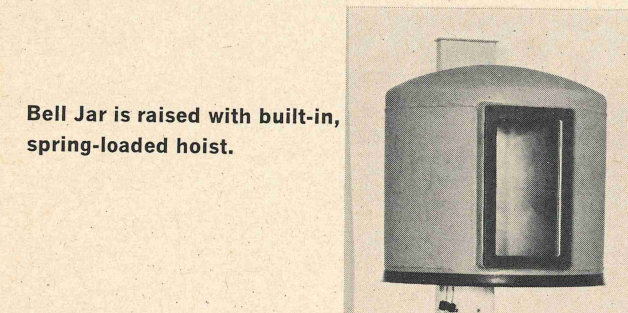
CENTRAL SCIENTIFIC COMPANY

CENCO VACUUM COATER

- Two built-in electronic vacuum gages
- Single lever valving control
- Implosion proof aluminum bell jar
- Ultimate vacuum of 2 x 10⁻⁶ Torr

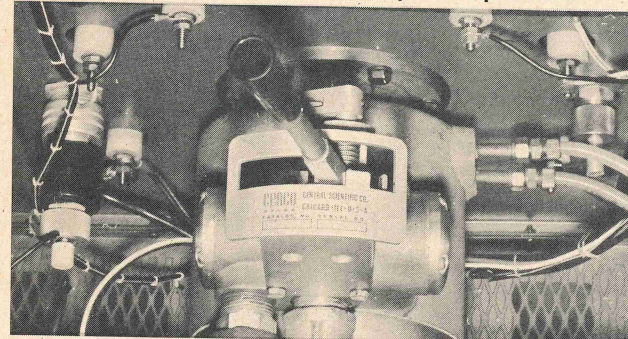


Easy-to-read control panel for operator convenience.



Bell Jar is raised with built-in, spring-loaded hoist.

Includes Cenco's 3-Way Valve for simplified operation.



SPECIFICATIONS

TYPICAL PUMPING TIMES

- empty bell jar
- 1 millitorr in 5 minutes
- 0.1 millitorr in 8 minutes

ULTIMATE VACUUM

2 x 10⁻⁶ Torr

ALUMINUM BELL JAR DIMENSIONS

18" diameter
18" high

COOLING WATER

0.1 gallon per minute

VACUUM GAGES

discharge in base plate
thermocouple in foreline

POWER SUPPLIES

5000 volts, ac, 30 ma.
12 volts, ac, 100 amps.

INPUT POWER

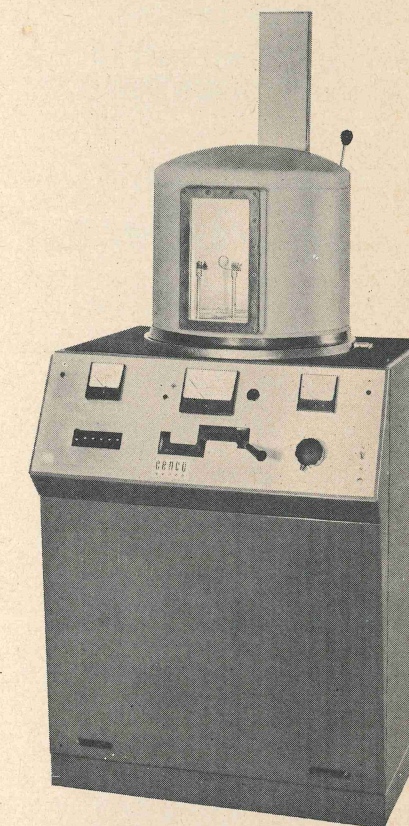
115 volt, 60 cycle, 30 amps.

OVER-ALL SIZE

71" high, 30" wide, 32" deep

SHIPPING WEIGHT

616 pounds



A compact, completely self-contained unit designed for use in research laboratories, industrial production and pilot plants. This unit is ideal for high vacuum deposition of metals and optics and other surfaces. Within 5 minutes, the bell jar can be evacuated to a working vacuum of 1 millitorr* and within 8 minutes will attain 0.1 millitorr.

The 19" diameter pump plate is connected through the Cenco Three-way Valve to a high speed diffusion pump that is backed by a Hyvac 14 mechanical pump. The Three-Way Valve replaces the roughing, foreline and high vacuum valves used in conventional systems. The single lever operation eliminates the lack of reliability and high cost associated with pneumatic and solenoid operated valves. It also prevents costly errors due to operating the valves in the wrong sequence.

A built-in, water-cooled baffle minimizes backstreaming from the diffusion pump. The implosion proof aluminum bell jar offers full visibility of the chamber interior through a large plastic window, and is raised by a self-contained, spring-loaded hoist. The pump plate is supplied with nine feed-through electrodes rated up to 5000 volts. Two pairs of electrodes carry 0-12 volts ac at 100 amperes from a built-in power supply. Another electrode maintains a glow discharge from the built-in 5000 VAC power supply to clean objects before coating. Four remaining electrodes, connected to external jacks on the front panel, extend the versatility of the coater by permitting electrical measurements of phenomena to be made from outside the bell jar or power can be introduced to operate rotating sectors or other devices in the vacuum chamber.

The vacuum gages included are a discharge in the base plate and a thermocouple in the foreline. Over-all dimensions are 71" high, 30" wide and 32" deep. Operates on 115 volt, 60 cycle, 30 amp.

No. 94700

\$3950.00

CENTRAL SCIENTIFIC COMPANY



A new concept offering:

Higher performance
Immediate delivery
Stock system prices

for a pumping system built to
your **EXACT SPECIFICATIONS**

CENCO MODULAR VACUUM SYSTEMS

An extensive selection of high performance vacuum components has been developed, manufactured, and put into stock at Cenco's main vacuum plant. This complete line has been designed to be quickly inter-connected without modification to construct a wide variety of systems, each tailored to the particular needs of the user. An attractive group of heavy metal cabinets efficiently house the different arrangements so that a complete "customized specified" unit can be rapidly assembled and delivered to the user's plant without the delay of making up special parts or cabinets. Additional components can be added later without expensive modifications since all pieces in this line are matched or "System-Mated."

With this "System-Mated" concept, the user has a freer choice of features—from a simple mechanical production pumping unit to a completely automatic ultra-high vacuum research system.

CHOICE OF 4", 6" or 10" SYSTEM

Depending on the speed of pump down required, the complete system should be built around a high quality diffusion pump of the proper size. The new Cenco high speed diffusion models feature all stainless-steel jets and improved boiler design which allow the pump to heat up and cool off more quickly. This boiler design, coupled with much improved tolerance to changes in forepressure and bell jar loads, enables the whole system to carry out a wider variety of functions without changing equipment.

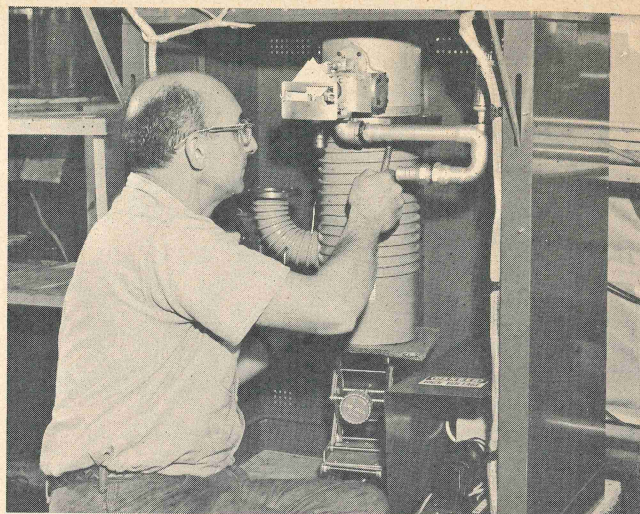
AUTOMATED CONTROLS AVAILABLE

A complete, automatic cycling unit is available that will bring the whole system through roughing, blank-off, high voltage clean-up, pump down, and pre-set vacuum level alarm without attendance. All valving is electronically controlled, pneumatically activated for positive, snap action response.

CUSTOM VACUUM SYSTEMS

In certain instances, unusual requirements preclude using even Cenco's "System-Mated" components throughout a system. However, Cenco has a fully staffed custom design and fabrication section which can produce special vacuum items or whole systems on order. For quotation and delivery schedule, send your requirements to:

Mgr., Vacuum Development Laboratories
Central Scientific Company
1700 West Irving Park Rd.
Chicago, Illinois 60613

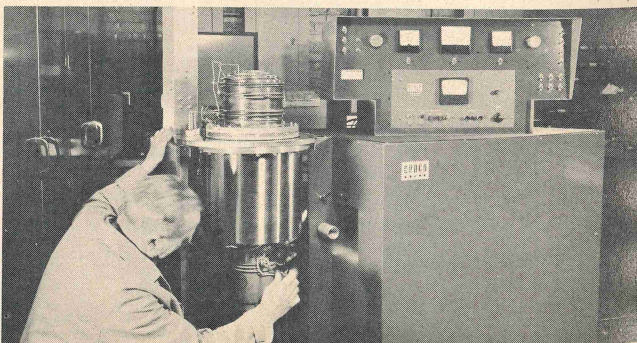


A Cenco Modular Vacuum System can be immediately fabricated with a choice of the following components:

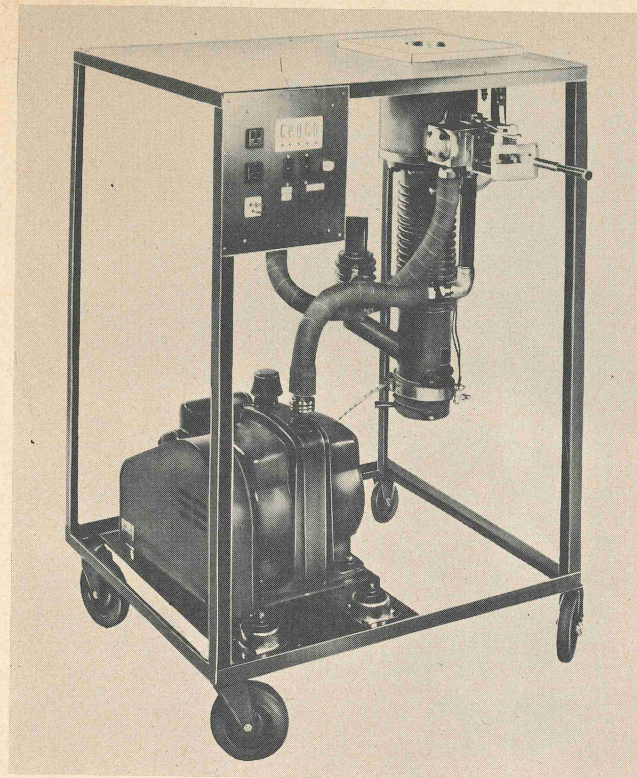
COMPONENT	CHOICES
Bell Jar	Aluminum, Pyrex Glass
Manifold Vacuum Fittings, Stainless	L, T or X
Gasketing	Elastomeric, Gold, Aluminum
Gate Valve	Pneumatic, Manual
Gages	Discharge, Bayard-Alpert Ionization, Pirani, Thermocouple
Trap, Cold Finger	CO ₂ , N ₂
Baffle	Water-Cooled
Diffusion Pump	Carbon Steel, Stainless Steel
Foreline Trap	Aluminum, Stainless Steel
Mechanical Pump	Single Stage, Two Stage
Foreline Valves	Pneumatic, Mechanical
Cabinet	To fit system and controls
Base Plates	To fit bell jar
Power Supplies	As required

**WRITE FOR THE CENCO MODULAR SYSTEM
SELECTION HANDBOOK**

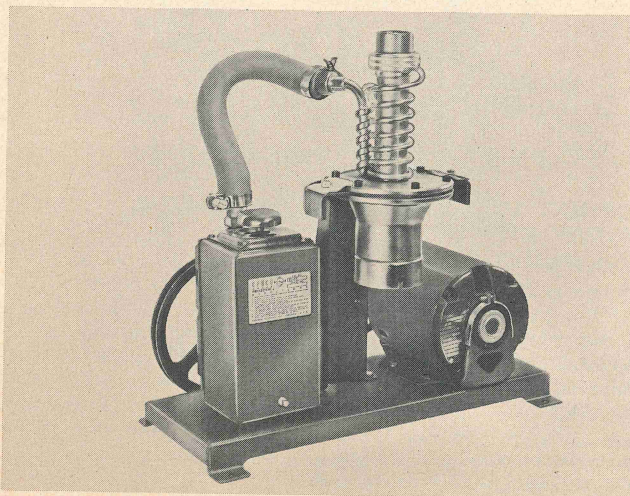
With this Handbook, the potential vacuum user can design his own system from the listed Cenco "System-Mated" components. He can also project ahead the cost of adding extra capacity or speed or measuring components to an anticipated system. This is, of course, free of charge to bonafide industrial and educational institutions.



CENTRAL SCIENTIFIC COMPANY

**SPECIFICATIONS**

DIFFUSION PUMP	
Pumping speed, liters/second	1000
Throat, I.D., inches	5.25
Cooling water required, GPM	0.25
Oil capacity, cc	285
Heater Wattage	1200
MECHANICAL PUMP	
Type	Single-Stage
Pump speed, liters/minute	280
Ultimate vacuum, microns of Hg	5
Oil capacity, pints	5
Length, overall, inches	24
Width, overall, inches	25
Height, overall, inches	39
Line Voltage	115, 60 cycle AC
Water Connections, O.D., inch	3/8
Vacuum Inlet, O.D., inches	4



CENTRAL SCIENTIFIC COMPANY



CENCO MOBILE VACUUM SYSTEM

Matched Cenco components

Cart-mounted for complete mobility

Consists of essential components matched and assembled to make up an efficient diffusion-mechanical pumping system, all mounted in a steel framed pump cart on heavy casters. Each system is made up of:

Hyvac Single Stage Forepump
Oil Diffusion Pump, Water Cooled
3-Way Valve & Water Cooled Baffle
Pump Case Plate
Switching Panel & Light
Auxiliary Outlets, 2
Interconnecting Hardware
Steel Cart with Casters

Ample space is provided for mounting accessories as needed, for example: No. 94178 Thermocouple Gage (1 to 1000 millitorr) or the No. 94183 Discharge Gage and Controller (0.001 to 20 millitorr). The sensing tube for the latter can be ordered already installed in the system foreline "T" connection. A belt-guard completely covers the rotating parts of the mechanical pump which, in turn, is shock and vibration-proof mounted in the pump cart.

The diffusion pump heater circuit is controlled by a main switch and an adjustable thermostat mounted directly on the pump casing. A panel light shows when this circuit is operating. The water cooled baffle in the 3-Way Valve cuts pump backstreaming to a minimum. The 3-Way Valve dispenses with foreline valves, thus eliminating extra operations and any possibility of an incorrect cycling sequence by inexperienced personnel. Two grounded utility outlets along with the mechanical and diffusion pump power switches make up the operating panel. Other controls can be mounted in the space left over.

The whole unit can be quickly rolled into position and put into immediate operation by simply plugging in the power line, connecting the water lines and turning on the forepump power switch.

If very high vacuum is not required in a particular operation, the forepump alone can be operated to obtain vacuum as low as 10 microns and a free air pumping capacity up to 28 liters per minute.

NO. 94712 for 115 V, 60 cycle AC \$1527.00

For a system with a No. 94179 Thermocouple Gage Tube installed, add \$23.50.

**CENCO SUPERVAC OD-25 OIL DIFFUSION
HIGH VACUUM PUMP OUTFIT**

Evacuates a conventional system to pressures of 5×10^{-6} Torr* or less. Pumping speed at 10^{-4} Torr pressures is 25 liters per second or better. No freezing trap is required to attain the ultimate low pressure. A No. 93330 Cenco OD-25 Supervac All-Metal Diffusion Pump and a No. 90550 Motor-Driven Cenco-Pressovac forepump are the basic elements of this outfit. The OD-25 diffusion pump has a built-in heater. Inside diameter of pump intake is 1 1/2". Other parts include a vacuum rubber tubing connection, and a special support for the diffusion pump. The entire combination is mounted on a substantial steel base.

A supply of No. 93050 Hyvac Oil is provided for use in the forepump. For the diffusion pump No. 93261 Cencoil-B is recommended but is not furnished with the pump outfit. The diffusion pump heater consumes approximately 175 watts when connected to the recommended 115V., 60 cycle, ac line. Supplied with all-metal diffusion pump, motor-driven forepump, connecting tube, forepump oil and complete operating instructions.

No. 93275-1 \$305.00

THE EDUVAC

The Eduvac produces a high vacuum by taking air molecules out of circulation permanently. It does not eject them from the system, but instead traps them inside the pump on an active metal film. The electrical discharge between anode and cathode in the strong magnetic field ionizes some of the air molecules, which are then attracted to the negative titanium cathode. The high energy ions eject titanium atoms from the cathode. These titanium atoms are deposited on the pump's interior surfaces, to form an active film which traps additional air molecules. In this way, the Eduvac provides an easy-to-use pump which produces completely clean vacuum. No mercury or oil is used.

No auxiliary equipment is needed except a mechanical vacuum pump. In the Eduvac itself there are no moving parts, no cold traps to fill. Even a power failure during operation will not ruin the vacuum. The entire apparatus is so compact and light that it can operate on a desk top. The electronic power unit can be used by itself as an extremely valuable high voltage supply. The current and voltage reading meter also provides direct readout of any vacuum in the range of 1×10^{-4} to 5×10^{-8} Torr*.

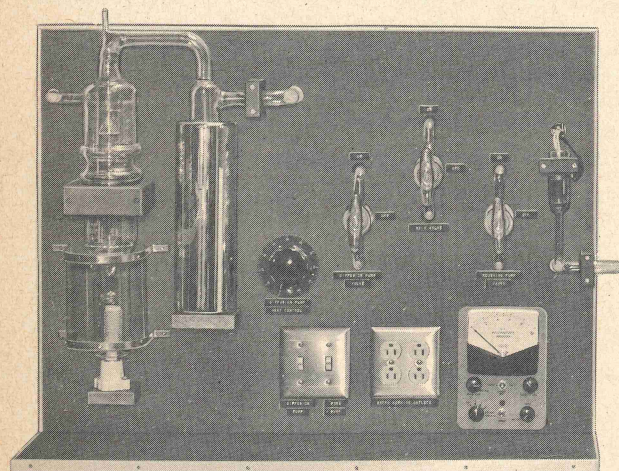
The unit consists of an electronic high vacuum pump with an Alnico permanent magnet and mounting bracket, a high voltage power unit rated at 3.2 KV dc no load, 150 ma short circuit current with grounded negative, a stainless steel base plate, 6" diameter, with port for mounting current feed-through, a Kovar feed-through with 8 separate prongs for high voltage connections and heating elements, a Hoke valve for valving off the mechanical pump after initial roughing, a choice of either a stainless steel bell jar or a two-liter pyrex bell jar (6" diameter, 6" high) with Viton gasket and complete operating instructions. The Eduvac carries a one-year unconditional guarantee. Operates on 115 volt, 60 cycle. Mechanical vacuum pump is not included.

No. 93215-1, with glass bell jar

\$ 950.00

No. 93215-2, with stainless steel bell jar

1500.00



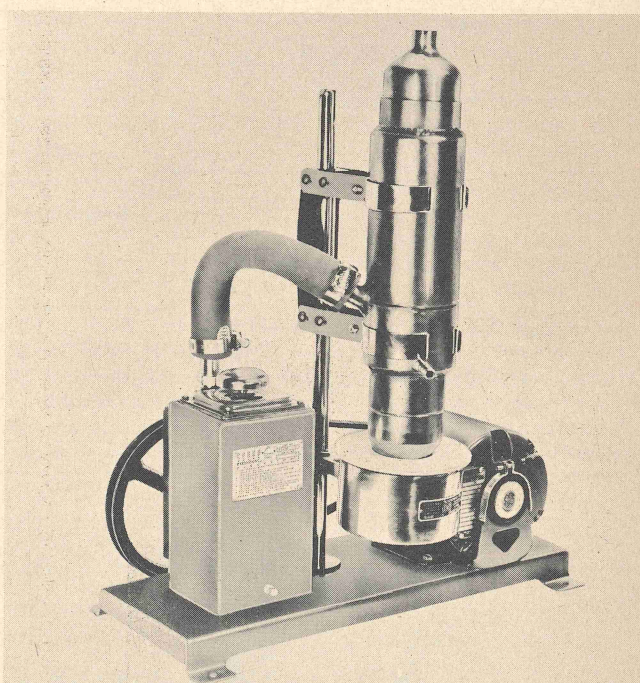
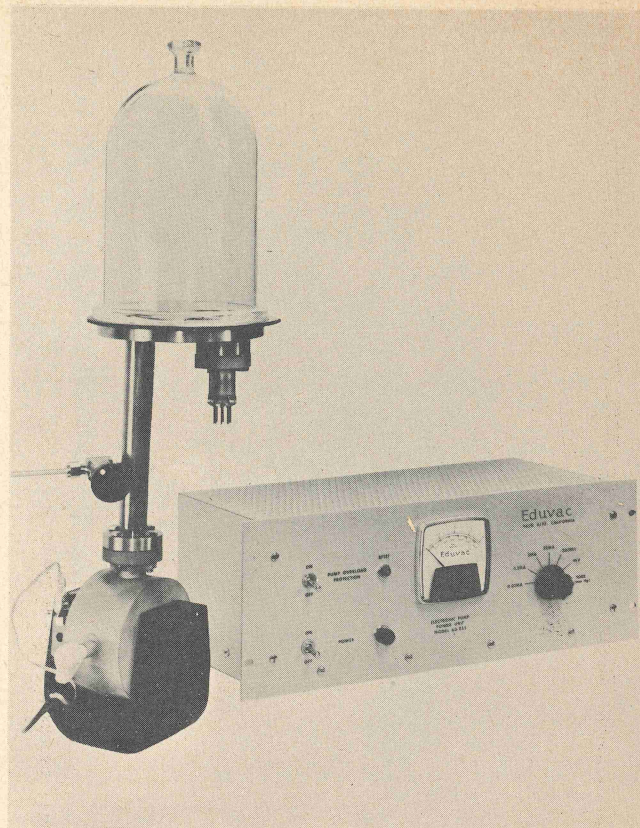
MERCURY HIGH VACUUM SYSTEM

Atomic Laboratories Mercury High Vacuum System consists of a Mercury Diffusion Pump, Diffusion Pump Heater, Cold Trap, Three Valves, Three pounds of mercury, and an Optional Ion Gage vertically mounted on a 4' by 4' board. All components and valves of the system are clearly marked. All connections are made in back of the board. The three vacuum valves permit opening the system under vacuum while maintaining low pressure in the diffusion pump. A safety sump eliminates backwash of oil from the forepump. Three vacuum stopcocks, when used in proper sequence, cut in the mechanical forepump for roughing while cutting out the diffusion pump. The stopcocks also permit both pumps to operate in series.

A special Atomic Laboratories Ionization Gage and Power Supply is optional with the system that includes a standard VG-1A tube plus a power supply with direct readout of vacuums from 9×10^{-3} to 5×10^{-7} Torr*. The filament in the VG-1A tube automatically cuts off if the system breaks or a leak appears. All the normal out-gassing equipment is also included.

No. 79649, without mechanical vacuum pump

\$550.00



CENCO MERCURY DIFFUSION HIGH VACUUM PUMP OUTFIT

Operates at a speed of approximately 7 liters per second at pressures of 10^{-6} Torr*. Largest diameter of the pump intake is 63 mm. Consists of a No. 93201 Cenco Mercury Diffusion Pump; a No. 90550 Cenco-Pressovac motor-driven Forepump; a No. 93210-3 Cenco Cone Type Electric Heater; a No. 93205-2 Cenco Support Clamp; and a No. 72185-1 Cenco Support Rod. Also included are a steel connection strip, a No. 94222 plastics tape and complete operating instructions. For operation on 115 volt 60 cycle ac. Requires 300 grams of mercury for operation.

No. 93265-1, without mercury

\$275.00



CENTRAL SCIENTIFIC COMPANY

VIRTIS FREEZE-DRY EQUIPMENT

- For small or large operations
- Manifold and bulk drying models
- Mechanically-refrigerated or dry ice models
- Wide choice of options and accessories

Leading specialists in freeze-drying, VirTis produces instruments that cover virtually every laboratory vacuum sublimation procedure. Freeze-drying, once a laboratory curiosity, has now become an essential investigative tool in the biological sciences. Tissue drying before sectioning, preservation of bacterial and virus cultures, drying of heat sensitive proteins, and a host of other important dehydrations can be performed efficiently and conveniently with modern VirTis vacuum sublimation instruments.

WIDE CHOICE OF EQUIPMENT

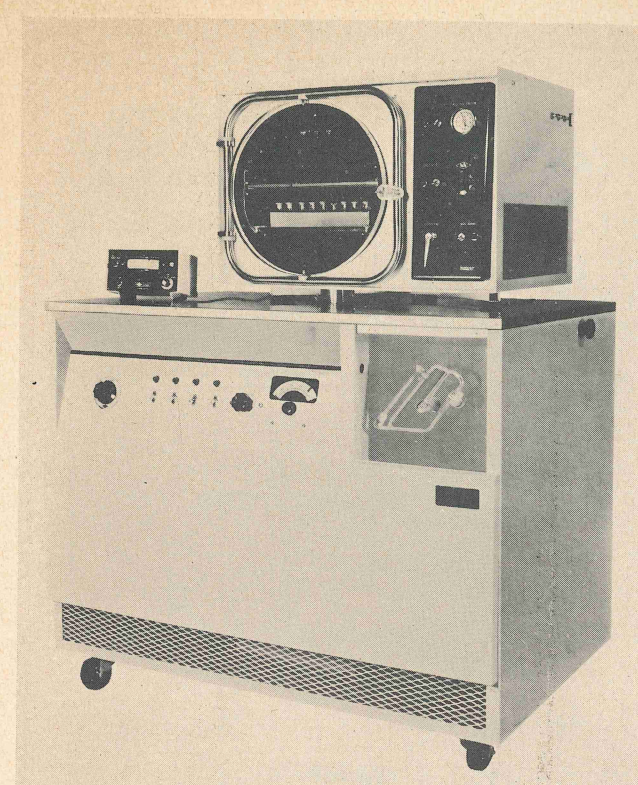
Units are available for uses ranging from small laboratory operations to batch processing. There is a choice of dry-ice units, mechanically refrigerated units, handy Freeze-Mobile Carts plus a host of other units. With the wide variety of options and choice of dozens of accessories, a unit can be set up to meet virtually any specific freeze-drying need.

CENCO STOCK DELIVERY

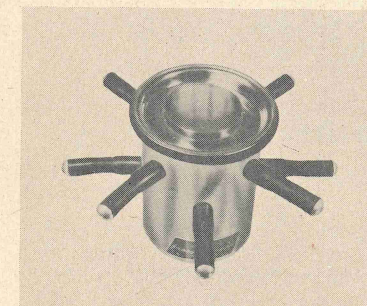
Cenco's nation-wide warehouse system assures you of prompt delivery on all VirTis equipment. Most basic units and many accessories are kept in stock at all times with special units quickly available whenever required.

COMPLETE VIRTIS CATALOG

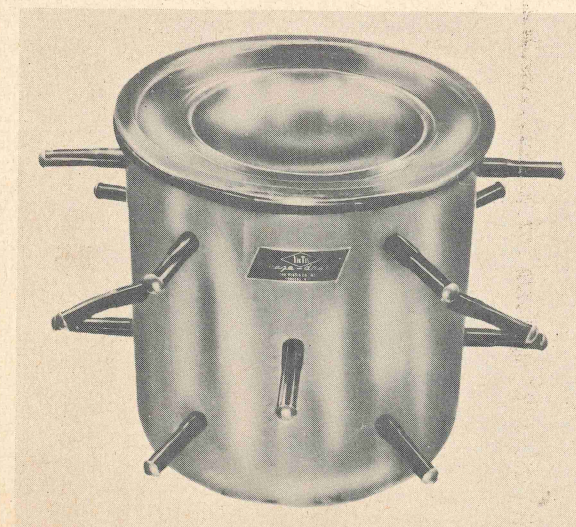
For a complete catalog of VirTis equipment including homogenizers, separators, and laboratory specialties as well as freeze-drying equipment, call or write your nearest Cenco Office.



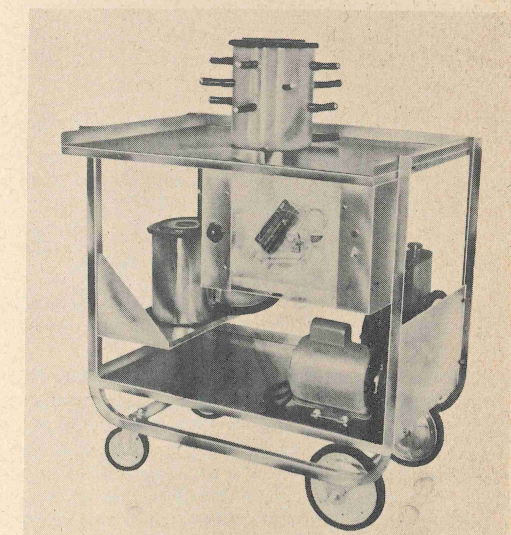
NO. 45200 Mechanically Refrigerated Cabinet with
NO. 45201 Vacuum Stoppering Tray Drying Chamber



NO. 45203-1 Micro Freeze-Dryer



NO. 45203-3 Super Freeze-Dryer

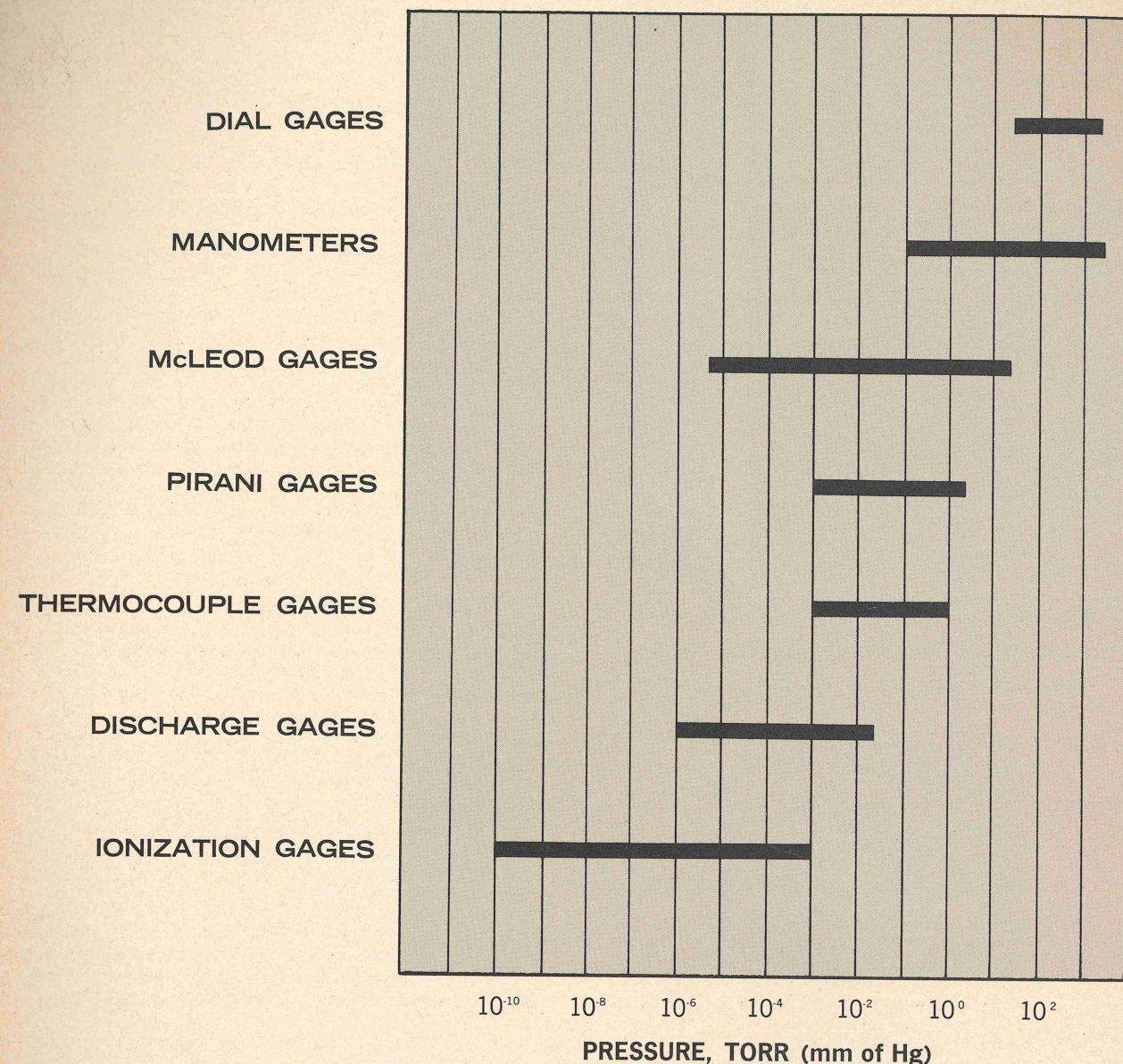


NO. 45208 Dry Ice Refrigerated Freeze-Mobile

CENTRAL SCIENTIFIC COMPANY



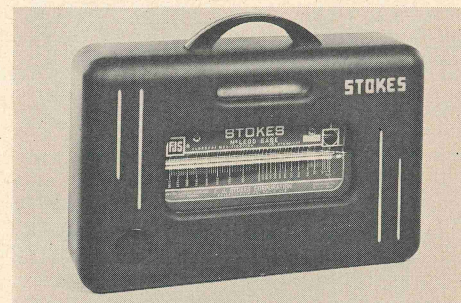
VACUUM GAGE SELECTION CHART



STOKES PORTABLE TABLE McLEOD GAGE

For quick and accurate measurements of pressures from 5 to 5000 millitorrs*. This instrument is useful in checking vacuum systems at various points, in locating leaks, in comparing conditions of operation, in measuring the efficiency of various pumps, and in standardizing and calibrating other types of gages for high vacuum measurement. It is self-contained, requires no adjustment, and is portable for use wherever required. A slotted swivel bracket is furnished for permanent attachment to any convenient support.

The gage rotates from the evacuating position to the reading position with no danger of breakage or spilling of mercury. Readings may be made in 5 seconds. A small window is provided for observing the zero point which may be adjusted at the time of installation. Accurate readings are provided by the proximity of the fully visible capillary and calibration scale to the open face of the plastic case. Lowest scale division is 1 millitorrs. A built-in, condensable vapor trap for pressures above 5 millitorrs is equipped with a replaceable chemical which changes color when replacement is required.



Glassware is of extra-heavy "Pyrex" brand glass. Connection to the gage may be made by rubber or plastics tubing, (for portable use), or a "sweated" copper fitting, (for permanent installation). Dimensions, over-all: height, 7½"; width, 11⅞"; depth, 4½"; net weight, 6½ lbs. Complete in plastic case, with carrying handle, mounting bracket and one pound of mercury.
No. 94135 \$120.00



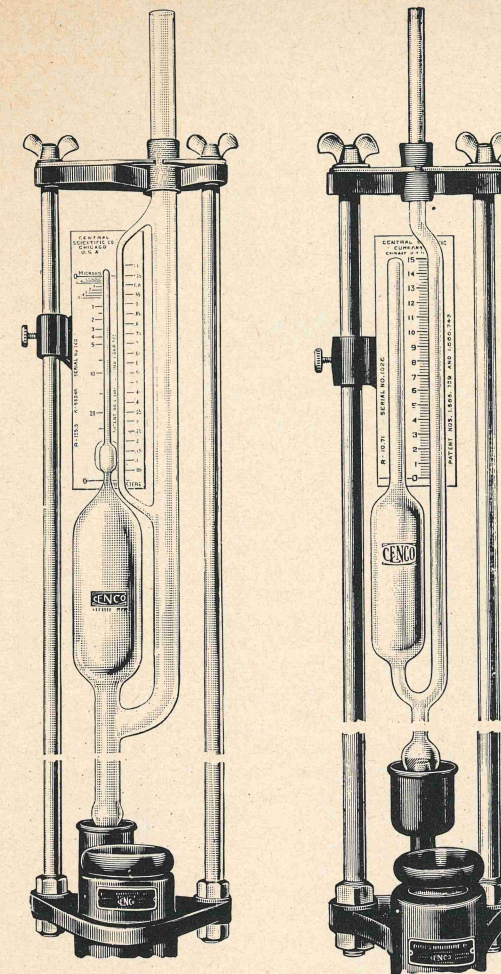
CENTRAL SCIENTIFIC COMPANY

CENCO McLEOD GAGES

These fine instruments were developed, after years of accumulated experience, in the Cenco Research and Testing Laboratories. Many exclusive features contribute to their enduring accuracy and economical continuous use, including:

1. No rubber connections to contaminate the mercury.
2. Interchangeable and replaceable measuring heads made of precision bore, Pyrex brand glass. A separate measuring head may be purchased as a "spare" so that one may be used while the other is being cleaned. Smaller dimensions than usual are used, thus facilitating cleaning. The small size and strong Pyrex brand glass reduce the hazard of breakage.
3. Hand calibrated scales with double range. The two ranges overlap so that no uncalibrated region exists. As both scales are direct reading, no calculations are necessary.
4. Mercury seal for the ground joint at the bottom of the measuring head.
5. Plunger controlled mercury level with the upper end of the plunger threaded to provide micrometer type control, the remainder smooth to allow quick readings. Readings are obtained by elevating the mercury in the measuring head by lowering the plunger in the mercury reservoir. The threaded portion is then engaged, affording precise setting.
6. Corrosion-resistant finishes used throughout.
7. Construction is very sturdy with heavy tripod base for stability.

In addition to its ordinary use, the gage may be made the basis of an interesting experiment in correlating the various types of discharge in a vacuum tube with the actual pressures as shown on the gage. As the McLeod gage is dependent on barometric pressure, the altitude where it is to be used must be known. The gages described here are for use from sea level to 3500 feet. Gages for use in altitudes over 3500 feet can be supplied on special order.



94156

94160

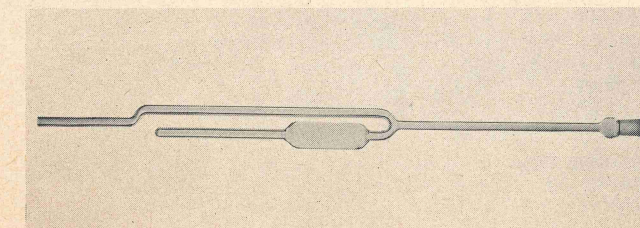
CENCO McLEOD GAGE, IMPROVED DESIGN DOUBLE RANGE

Similar to the No. 94151 but for pressures from about 0.005 to 1000 millitorrs*. Double range, with one scale reading to approximately 25 millitorrs and the other to approximately 1000 millitorrs. This gage is intended for use in a system being exhausted by means of a diffusion or a molecular pump. It is made with replaceable precision bore tubing. This gage requires about 30 pounds of mercury for operation. Over-all height is about 190 cm; weight, without mercury, is about 45 lbs.
No. 94156, without mercury \$285.00

CENCO MERCURY FOR McLEOD GAGES

CP, ACS, Triple distilled quicksilver.

1 pound, bottle	\$12.60
5 pound, bottle	56.50
15 pounds maximum quantity for parcel post shipment.	



CENTRAL SCIENTIFIC COMPANY



CENCO McLEOD GAGE, SINGLE RANGE

Similar to No. 94151 McLeod Gage, but with single range from 0 to 15 torrs, reading to 0.1 torr. Scale magnification by the McLeod principle is about 10. For accurate measurement of gas pressures in the filling of discharge tubes and in measurements of pressure in industrial processes. About 10 lbs. of mercury are required.
No. 94160, without mercury \$170.50

CENCO McLEOD GAGE, DOUBLE RANGE

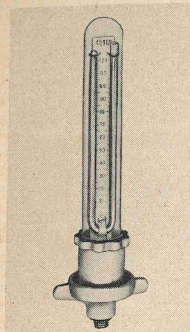
For all measurements of pressure from 0.5 millitorr* to 1600 millitorrs. One range reads in millitorrs from 0.5 to about 200 or 250; the other to about 1.6 torr. Over-all height is 165 cm. The amount of mercury required is about 10 pounds. Weight, without mercury, 30 pounds.
No. 94151, without mercury \$205.00

McLEOD GAGE GLASSWARE

Extra glassware for Nos. 94151, 94156 and 94160 Cenco McLeod Gages. Consists of calibrated glass head with interchangeable ground joint and a calibrated scale.

CENCO NO.	McLEOD GAGE NO.	O.D. CONNECTING TUBE	EACH
94165-3	94160	10 mm	\$67.50
94165-4	94156	18-19 mm	88.00
94165-5	94151	10 mm	88.00

MANOMETERS

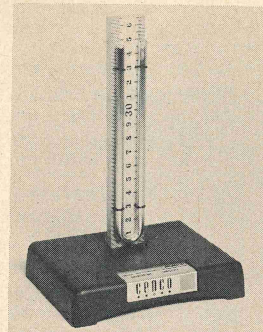


94105

MANOMETER VACUUM GAGE

For use with air pumps which are provided with a 7/16" opening tapped with 16 threads per inch. Enclosed in a glass tube with a 12 cm metal scale, graduated from 0 to 120 mm, with 1 mm divisions. Filled with mercury ready for use.

No. 94105



94100

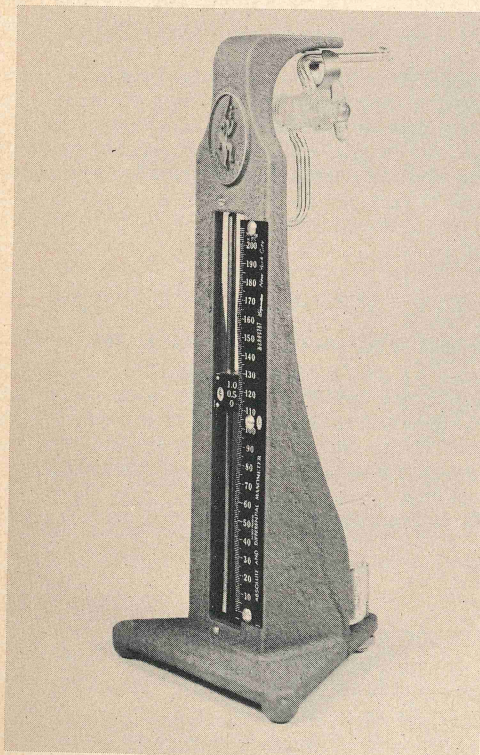
MANOMETER VACUUM GAGE

To be used under any bell jar 8" or more high. Tube is mounted on a base with a mm scale. Height, 7 1/4". Filled with mercury ready for use.

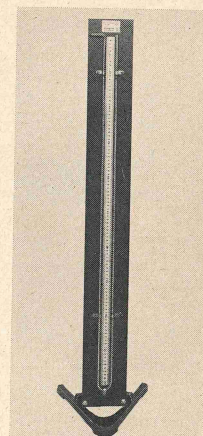
No. 94100

\$30.50

\$7.75



94106



94125

GLASS MANOMETER — SINGLE OR DOUBLE CONNECTION

For measurement of pressure in vacuum distillations and similar operations where scale readings to 1 mm of mercury are sufficient. Made of Pyrex brand glass with body graduated in red from 0 at the bottom to 160 mm at the top in 1 mm divisions. The top of the body tube has a standard taper grinding for the inner tube with stopper top. Connection with the vacuum system is made through a side arm. Also available with two side arms. Complete instructions for filling are included. About 160 grams of mercury are required. Length, over-all, 235 mm.

No. 94106, one side arm, without mercury

\$12.87

No. 94109, two side arms, without mercury

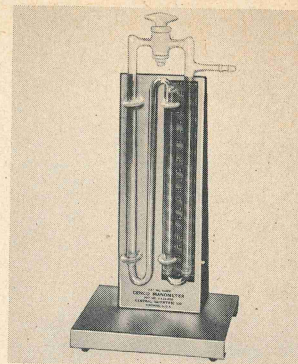
13.64

PRESSURE AND VACUUM MANOMETER

For measurement of either pressure or vacuum to 1 atmosphere above or below standard barometric pressure. Its range is, therefore, from zero to 2 atmospheres in terms of absolute pressure. It consists of a U-tube mounted on a metal support with a metric scale. Both ends of the tube are open and one end is turned at right angles and provided with serration for connection to the apparatus in which the pressure is to be measured. The supporting board is mounted on a heavy iron base. About 350 grams of mercury are required.

No. 94125, without mercury

\$18.25



CENCO GLASS MANOMETER

Made under Wyandotte Chemical Corp. Patent No. 2,438,228. For measurement of vacuum from 180 Torr down to 1 Torr with accuracy of ± 0.5 Torr. Scale ranges from 0 to 20 cm in 1 mm divisions. A three-way stopcock is provided. Entire assembly is mounted on a stainless steel support. Graduations are etched on the mounting behind the U-tube for easy reading.

A special feature of the manometer is the ease with which the U-tubes may be filled with mercury and the pressure measured. Removing the mercury, cleaning the tubes, and refilling are also quicker and easier than with ordinary closed-end glass tubes. Approximately 12 cc of mercury are required with the gage. Stopcock size, ST No. 2; height, over-all, 33 cm.

No. 94122, without mercury

\$38.75

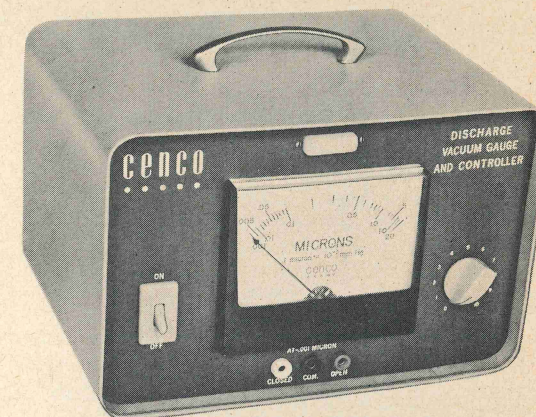
CENCO DISCHARGE GAGE

- Shock resistant tube
- Constant line voltage transformer
- Responds to both condensable and non-condensable vapors
- Lightweight

Continuous and direct pressure readings from all condensable vapors and permanent gases present in a vacuum system are indicated on a single meter scale. Measures vacuum continuously from 0.001 millitorr* to 20 millitorr. The calibrations is standardized with a McLeod Gage using dry air. The Discharge Vacuum Gage includes a transistorized dc amplifier and relay to operate auxiliary equipment such as pumps, heaters, etc., at any desired pressure on the scale. Both normally-open and normally-closed contacts are provided through banana jacks on the front panel, permitting the apparatus to be started and stopped at a given pressure. A built-in regulating transformer accommodates line voltage variations.

The Cenco Discharge Tube is a cold cathode glow discharge type and is shock resistant. The metal shell of the tube serves as the cathode. A permanent magnet produces a strong magnetic field across the tube. The cathode shell and anode loop wire are made of aluminum. It has a very low sputtering rate. Operation is based on the principle that ionization current, due to the collision of gas molecules and electrons, is a function of pressure. This circuit is read on the microammeter which is calibrated in millitorrs.

The open end of the discharge tube, 1" OD, is connected into the vacuum system by means of suitable vacuum fittings, gage ports, etc. A 6 foot, plastic covered, coaxial wire with connector is supplied for attaching the discharge tube to the Discharge Vacuum Gage.



Internal relay can be set to stop or start auxiliary equipment at any pressure within the operating range.

Dimensions of the Discharge Gage are 16 1/4" long, 7 1/2" high and 6 3/4" deep. Attractively finished in blue and beige enamel. Available with either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Relay contacts are rated for 1 ampere. For heavier loads, a No. 99720-1 or 99725 relay may be used. Supplied with a 3-wire line cord and plug for ground connections. Shipping weight is 15 pounds.

No. 94183-1, 115 volt, 60 cycle, ac

\$295.00

No. 94183-8, 230 volt, 50 cycle, ac

325.00

DISCHARGE TUBE

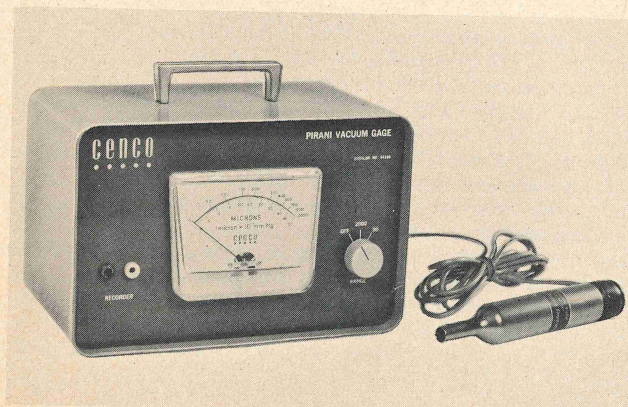
A cold cathode glow discharge type for replacement in No. 94183 Discharge Gage.

No. 94187

\$49.50

CENCO PIRANI GAGE

- High Stability
- Two-scale meter
- Full range from 1×10^{-3} torr* to 2 torr
- Easy to operate



The Cenco Pirani Vacuum Gage, a thermal conductivity type, is based on the temperature and/or resistance change of a heated filament. This change or unbalance is measured on a conventional wheatstone bridge circuit. One arm of the bridge utilizes a compensating tube, sealed under vacuum, to make the circuit insensitive to ambient temperature changes. Pressure is continuously read on a meter having two scales calibrated to the bridge unbalance. One range is 0 to 50×10^{-3} torr, and the other is 50×10^{-3} torr to 2 torr. The power supply is a full wave bridge rectifier using a constant voltage source. This makes the instrument very stable. Two banana jacks are located on the front panel for recorder use.

The Pirani tube consists of a sensing tube and metal compensating tube, both mounted in a single nickel-plated steel envelope. This combined tube is smaller, more rugged, and easier to install than many other Pirani Tubes.

Zero drift, which can be a serious problem in Pirani Gages, has been corrected to a great extent by operation of a filament at a much lower temperature (a maximum of 250° C. at a pressure well below 1.0 millitorr*) and by inorganic treatment of the filament to provide a stable, inorganic, black surface. The Pirani tube is 7" long with an envelope OD of 1 1/4" and a tubulation OD of 1/2". The Cenco Pirani Vacuum Gage is 10 1/4" long, 6 1/2" high, and 5 1/2" deep. Attractively finished in blue and beige enamel, it is available with 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. The power consumption is 12 watts. Net weight is 8 pounds.

No. 94190-1, 115 volt, 60 cycle

\$189.00

No. 94190-8, 230 volt, 50 cycle

197.50



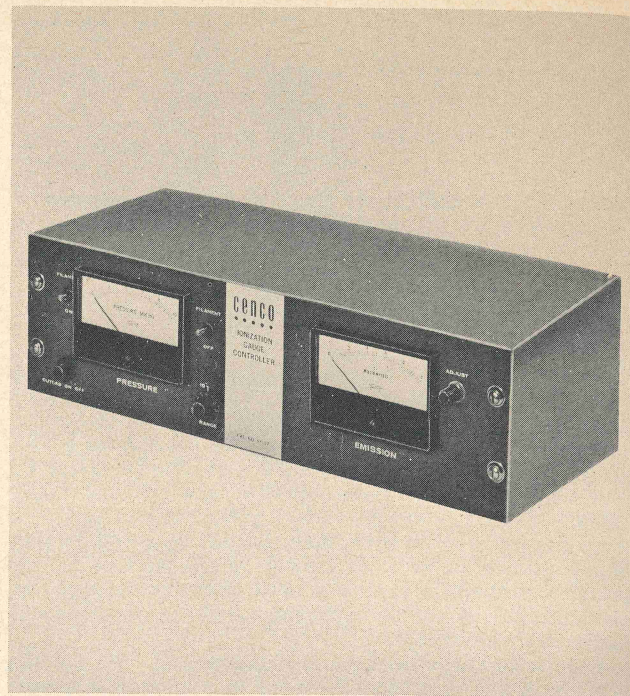
CENTRAL SCIENTIFIC COMPANY

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CENCO IONIZATION GAGE

- Two new models
- Measures from 1×10^{-3} to 2×10^{-10} torr
- Uses all standard ionization gage tubes
- Optional auxiliary equipment control at pre-set pressure



This excellent Ionization Gage incorporates a wide range electrometer amplifier and is designed for use with Bayard-Alpert inverted ionization gage tubes. With it, dry air pressure measurements can be in the range from 1×10^{-3} to 2×10^{-10} torr.

CIRCUITRY

Six separate circuits are used in the Cenco Ionization Gage: a power supply, an electrometer type ion current amplifier, an over-pressure protective circuit, an emission current regulator, a grid outgassing circuit and a recorder output circuit. The amplifier has near 100% negative feedback to provide excellent stability in reading the ion currents from the gage tube collector. The protective circuit controls the filament circuit and, in the event of an overpressure condition, turns the filament off. The emission regulator is a constant current device with a wide range of adjustments permitting gage tubes with different sensitivities to be used without the need for time-consuming recalibration of the amplifier. The regulator corrects for line voltage fluctuations, pressure changes, and emitter work function changes. The grid outgas circuit supplies current to the grid of the ionization gage tube to bring the grid to a bright red heat for outgassing of the gage tube walls. The recorder output is variable between 0 and 10 millivolts for full scale reading of the pressure meter.



SIMPLIFIED CONTROL PANEL

Controls are grouped for easy reading and use. The pressure gage is calibrated in 100 divisions from 0 to 10. A six decade range switch can be set for readings from 10^{-3} to 10^{-10} . Filament on and off switches have built in pilot lamps. The outgas circuit switch and emission gage are also mounted on the front panel.

CONTROLLER MODEL

The No. 94198 is provided with a SPDT, 3 ampere, contact meter relay that can be set to turn auxiliary equipment on or off at any pre-set pressure within the range of the gage. A setting control is provided on the front panel.

SPECIFICATIONS

OPERATING RANGE, torr	1×10^{-3} to 2×10^{-10}
ZERO DRIFT, % of full scale	2
OVERPRESSURE CIRCUIT, % of full scale	125
OPERATING VOLTAGE	115, 60 cycle
WATTAGE	
Operating	67
Outgassing	110

Gages are supplied with a 3-wire line cord and plug for connection to a power line, a 4-wire gage power cable, and a coaxial cable for ion collection.

NO. 94197 without controller	\$475.00
NO. 94198 with controller	\$565.00

IONIZATION GAGE TUBES

Hot filament tubes for use with the Nos. 94197 and 94198 Ionization Gages. All types utilize the Bayard-Alpert inverted element configuration and are suitable for measuring pressure in the range from 10^{-3} to 10^{-10} torr. The tubes are provided with three filaments that can be used separately or collectively to allow either for longer tube life or higher gage sensitivity when using higher electron currents to the grid. Tube sensitivity is 60 microamperes per micron when using 5 milliamperes grid current or 100 microamperes when using $8\frac{1}{3}$ ma grid current.

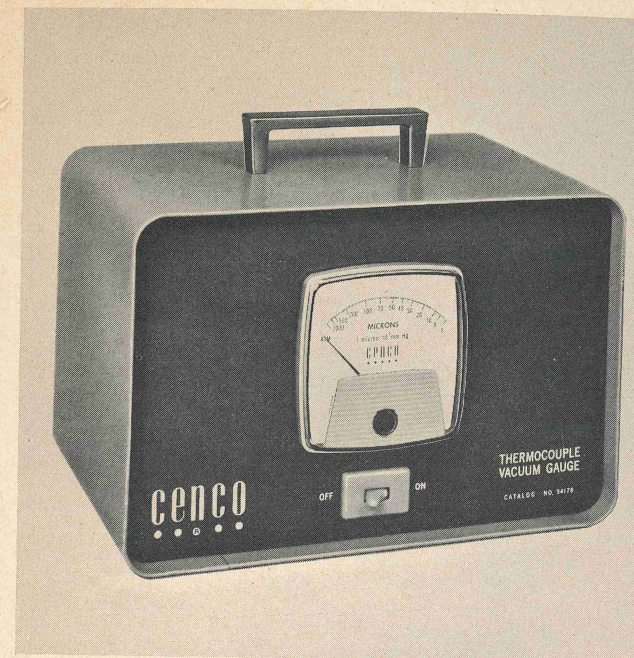
Four types are available, three with tubulation enclosed filaments and one with filaments exposed for extremely accurate readings. Connections are provided to outgas the grid structure by passing current through the grid element.

NO. 94195-1 With $\frac{3}{4}$ -inch Nonex tubulation	\$35.75
NO. 94195-2 With $\frac{3}{4}$ -inch Pyrex tubulation	37.50
NO. 94195-3 With $\frac{3}{4}$ -inch Kovar tubulation	40.00
NO. 94196 Without tubulation	64.00



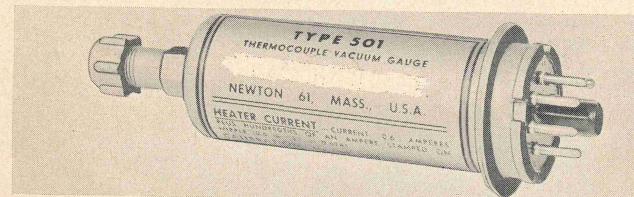
CENTRAL SCIENTIFIC COMPANY

CENCO THERMOCOUPLE GAGE



Measures pressures in the range of 1 to 1000 millitorrs* and reads directly on a single meter scale. Adjusted and calibrated for immediate use, this lightweight gage responds to both condensable and non-condensable gases. The all-metal thermocouple tube resists contamination, physical shock and may be operated at atmospheric pressure. The gage tube has a standard $\frac{1}{8}$ " NPT male thread, is $5\frac{1}{4}$ " long and a 1" diameter. A 5 foot, plastic covered, 4-wire cable with octal socket is supplied for connecting the thermocouple tube to the Thermocouple Gage supply. A separate meter is not required for the heater current. A constant voltage transformer accommodates line voltage variations. Dimensions are $10\frac{1}{4}$ " long, $6\frac{1}{2}$ " high and $5\frac{1}{2}$ " deep. Attractively finished in blue and beige enamel. Available with either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Supplied with a 3-wire cord and plug for positive electrical connections. Shipping weight is 12 pounds.

No. 94178-1, 115 volt, 60 cycle, ac	\$149.50
No. 94178-8, 230 volt, 50 cycle, ac	169.50



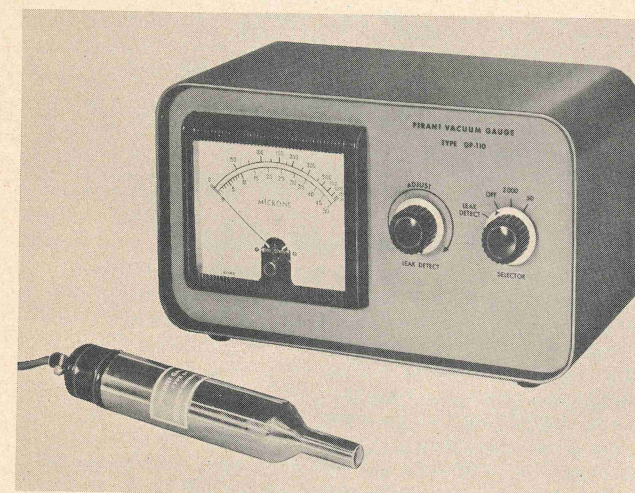
THERMOCOUPLE TUBE ADAPTER

No. 94177	\$1.00
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THERMOCOUPLE TUBE

An all metal, replacement tube for the 94178 Thermocouple Gage.

No. 94179	\$23.50
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PIRANI GAGE, CVC TYPE GP110

This gage gives continuous pressure readings from 1 to 2000 millitorrs* and measures the total pressure of condensable vapors and permanent gases present in a vacuum system.

In operation the gage employs a bridge circuit to balance the resistance of a filament which loses heat by conduction of the gas being measured. A change in pressure alters the balance of the circuit which is read directly in terms of pressure on the specially calibrated microammeter. The increased sensitivity of the gage in the presence of hydrogen or certain volatile organic materials permits its use in the detection of major leaks in the vacuum systems. By merely turning the selector switch to "Leak Detect" the gage is adapted to use for detecting leaks well beyond its normal operating range, (from 1 millitorr to 10 torr or higher).

To decrease the effects of ambient temperature, the sensing tube and compensating tube are both enclosed in a single metal envelope. An automatic voltage regulator provides easier operation and also allows the use of a recorder without constant attention from the operator. Two terminals at the back of the chassis provide the proper output to drive a 10 millivolt full-scale recorder.

The high range is 50 to 2000 millitorrs. The low range is 1 to 50 millitorrs. The tube is 7" long with an envelope OD of $1\frac{1}{4}$ " and a tubulation OD of $\frac{1}{2}$ ". The maximum filament temperature is 250° C. Operates on 115 volt, 60 cycle, ac with a power input of 15 watts.

No. 94185	\$208.00
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PIRANI TUBE, CVC TYPE 2201-03-15

For replacement in No. 94185 Pirani Gage. Consists of sensing tube and metal compensating tube, both mounted in a single nickel-plated steel envelope.

No. 94186-11	\$23.10
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MULTI-STATION PIRANI GAGES, CVC TYPE GP-140

Includes all of the features of No. 94185 described above but is available with two, three, or four sensing stations and has a four-position, station-selector switch on the front panel. If less than four sensing tubes are ordered initially, additional stations up to the maximum complement can be added simply by inserting the tube cable taper pins into receptacles in the printed circuit. Each station has three individual calibration potentiometers accessible from the back of the cabinet without removing the chassis. Complete with No. 94186-11 Pirani Tubes.

NO. 94172-1 Two-Station Gage	\$276.00
NO. 49172-2 Three-Station Gage	308.00
NO. 94172-3 Four-Station Gage	340.00

CENTRAL SCIENTIFIC COMPANY



**IONIZATION GAGE, CVC TYPE GIC-110A**

For direct reading of dry air pressures between 10^{-9} and 10^{-3} torr. An economical, hot-filament ionization gage which features automatic emission control. After the emission current has been adjusted to the proper value, the transistorized circuit automatically maintains it at this level. No. 94175-6 Gage Tube, Type GIC-017 is supplied which will measure pressures as low as 5×10^{-8} torr.

The gage covers the pressure range in 5 linear decades. The numerical value indicated on the metric scale calibrated from 1 to 10, multiplied by the power of 10 shown by the range selector switch, gives the pressure in millimeters of mercury. The meter also has another pressure scale calibrated in microns of mercury from 1 to 1000 which is usable only on the thermocouple circuit of No. 94193 Gage. The gage has an external circuit control and recorder connections. The case is 11" long, 6½" high, and 7" deep. Supplied with a 10 foot cord for operation on 115 volts, 60 cycles, ac with a power input of 100 watts.

No. 94192-2 **\$465.00**

**IONIZATION AND THERMOCOUPLE GAGE
CVC TYPE GIC-110A with GIC-002**

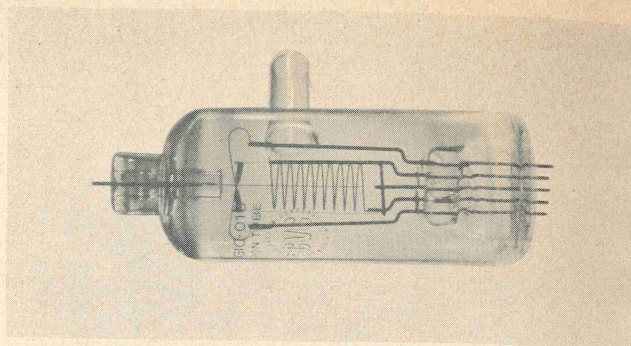
Same as No. 94192 Gage but with added 2-station Thermocouple Accessory Circuit and two No. 94194 Thermocouple Sensing Tubes internally connected. Pressure for either station may be read directly in millitorrs* on a special scale on the same meter used for the ionization gage reading. A switch on the front panel provides easy selection of the desired thermocouple station. For operation on 115 volts ac, 60 cycles.

No. 94193 **\$547.50**

**THERMOCOUPLE TUBE**

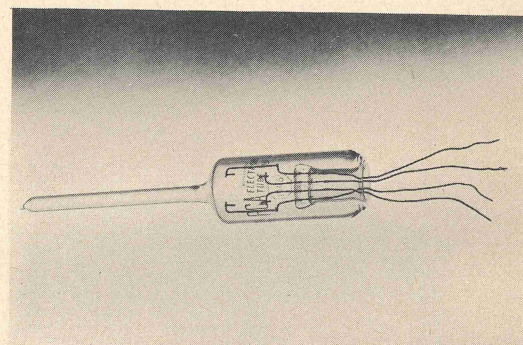
For replacement in No. 94193 Ionization and Thermocouple Gage.

No. 94194 **\$16.30**

**IONIZATION GAGE TUBES,
CVC TYPE GIC-015, -016 AND -017**

Hot filament ionization gage tubes for use in CVC Type GIC-110A or other ionization gages. Tubes are glass enclosed with Bayard-Alpert inverted element configuration. The tubes can be used for pressure readings from 10^{-3} to 10^{-10} torr. To insure long tube life, a dual filament arrangement is incorporated making it unnecessary to replace the entire tube each time a filament burns out. The filament and grid pins extend through the base of the tube; the collector pin is located at the opposite end. The collector plate is a single tungsten wire enclosed in a spiral grid. Sensitivity for air is 10 microamps per 10^{-4} at a nominal emission current of 10 milliamperes. The tube is designed for direct degassing with a grid current of 10 amperes at 6-8 volts and can be baked at 450°C after removing the connectors. All tubes are 2½ inches long, outside diameters vary as listed below.

No. 94175-4	½-inch O.D.	\$41.50
No. 94175-5	¾-inch O.D.	41.50
No. 94175-6	1-inch O.D.	41.50

**THERMOCOUPLE VACUUM GAGE**

For determining dry air pressures from 1 or 2 millitorrs* to 200 millitorrs by measurement of heat loss from a filament by means of a thermocouple. Readings of the thermocouple current increase with reduction of pressure and consequent decrease in conduction of heat from the filament by the air or gas. By calibrating the thermocouple against a McLeod gage, pressure values may be established for the thermocouple.

The gage consists of a Pyrex brand glass envelope, with a tubulation for sealing to the vacuum system, which encloses a filament having a small thermocouple welded to its midpoint. Four leads extend from the envelope, two for the filament heating current and two for the thermocouple. Length of gage tube, 4½"; diameter of gage, 1¾"; diameter of tubulation, ⅜". WITHOUT calibration curve, current source, or meters.

No. 94180 **\$26.00**

PIRANI TUBE, CVC TYPE 2201-03-15

For replacement in No. 94185 Pirani Gage. Consists of sensing tube and metal compensating tube, both mounted in a single nickel-plated steel envelope.

No. 94186-11 **\$23.10**



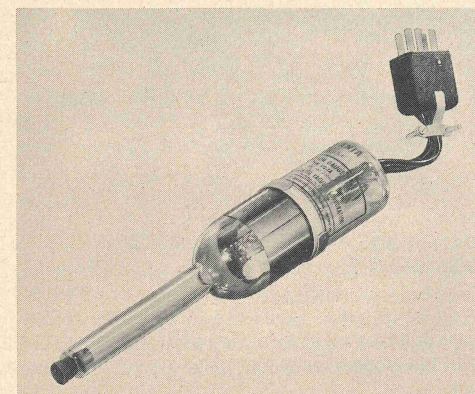
CENTRAL SCIENTIFIC COMPANY

IONIZATION GAGE TUBES

Hot filament tubes for use with the Nos. 94197 and 94198 Ionization Gages. All types utilize the Bayard-Alpert inverted element configuration and are suitable for measuring pressure in the range from 10^{-3} to 10^{-10} torr. The tubes are provided with three filaments that can be used separately or collectively to allow either for longer tube life or higher gage sensitivity when using higher electron currents to the grid. Tube sensitivity is 60 microamperes per micron when using 5 milliamperes grid current or 100 microamperes when using 8⅓ ma grid current.

Four types are available, three with tubulation enclosed filaments and one with filaments exposed for extremely accurate readings. Connections are provided to outgas the grid structure by passing current through the grid element.

No. 94195-1	With ¾-inch Nonex tubulation	\$35.75
No. 94195-2	With ¾-inch Pyrex tubulation	37.50
No. 94195-3	With ¾-inch Kovar tubulation	40.00
No. 94196	Without tubulation	64.00

**IONIZATION VACUUM TUBES,
CEC TYPE VG-1A**

For determining dry air pressures below 10^{-3} torr*. Measurement of electron currents is done in a special type of thermionic tube, modified to eliminate the possibility of grid-filament leakage through metallic films evaporated or spattered from the hot electrodes. A sensitivity of 120 microamperes per micron is possible under typical operating conditions. Values of grid voltage and current other than that of the typical operating conditions may be employed. Special reference curves for that purpose will be supplied on request. For maximum life, however, it is advisable to operate the gage with lower electron currents, particularly at pressures above 10^{-4} torr.

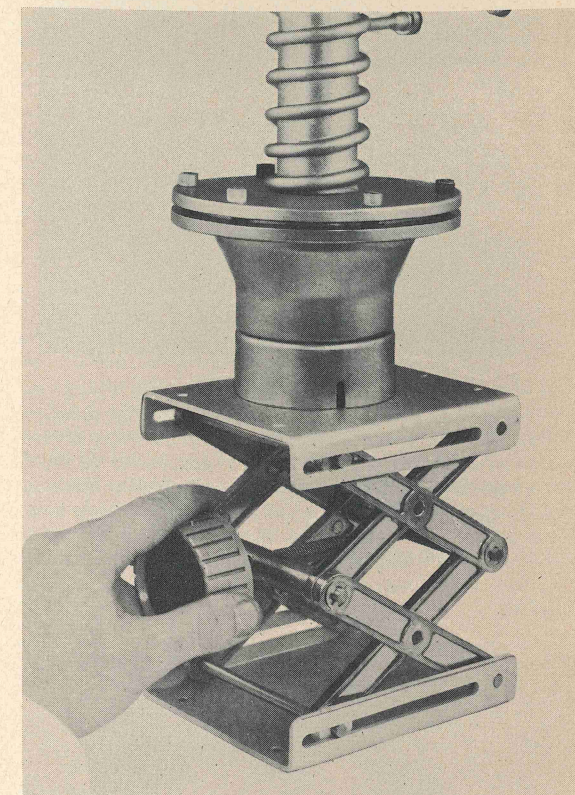
A Pyrex brand glass cell or envelope in which the filament, grid and collector or plate are sealed, is the basis for the tube. Leads to the electrical elements extend from the top of the envelope, while a tubulation extends from the bottom for sealing into the vacuum system at the point where the pressure is to be determined. The filament is of pure tungsten wire and may be operated from either batteries or a suitable power supply source. A rheostat should be provided so that the filament emission may be regulated to give proper constant electron or grid current.

The grid is of tungsten wire in the form of a spiral and has two leads for electrically heating to degas it. A current of 7 amps at 6.5 volts is adequate to bring it to incandescence. The plate or collector is a thin coating of platinum on the inside wall of the envelope. Its electrical connection is made with a unique type of glass-to-metal seal to eliminate the usual danger of cracking at this point. It is degassed with the envelope when touched with a flame.

Length of the tube is approx. 3½"; diameter of envelope, 1½"; diameter of tubulation, ½". Different types of tubulation available on request. This tube is available with a male Jones connector for attachment to meters; or without Jones connector, open. Without calibration curve, current source, rheostat or meters.

No. 94175-1, with Jones connector	\$32.00
No. 94175-3, without Jones connector, open	\$28.80

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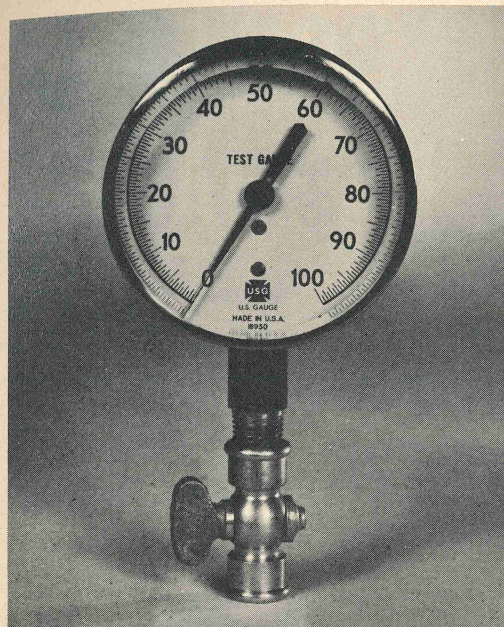
**CENCO-LERNER
LAB-JACK**

This unique Lab-Jack is the perfect adjustable support to use with complicated setups employing expensive ground joint glassware, heavy oil baths and mantle heaters, drying columns and condensers. Vertical movements are accomplished smoothly and precisely by simply turning the easily accessible, 1 inch thick, fluted knob. The Lab-Jack can be continuously elevated to 10¼ inches supporting loads of over 100 pounds regardless of the point of loading. Once elevated, it will not flex or tilt when a heavy load is applied. Constructed of machined stainless steel and aluminum, it will not corrode or loosen up under hard laboratory abuse.

SPECIFICATIONS

Top & bottom plates	4¾" x 5½"
Elevation range	2¾" x 10¼"
Maximum load	110 lbs.
No. 19089-001	ONLY \$34.00

DIAL GAGES

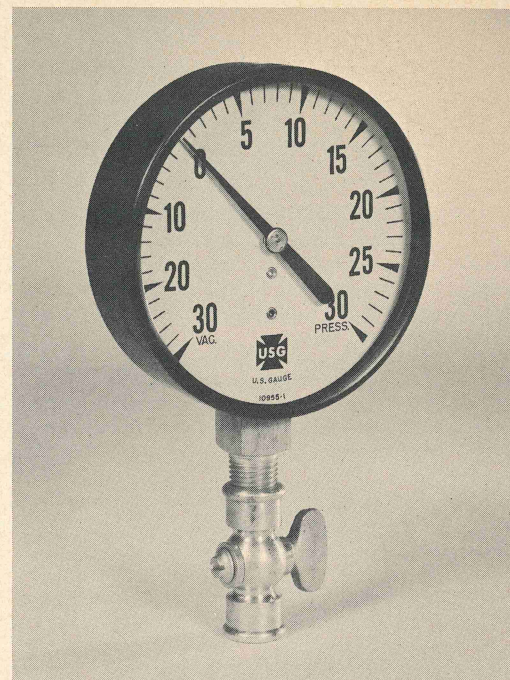


PRESSURE GAGE, STANDARD

A test gage of extreme accuracy graduated by means of an open column of mercury and tested under the most severe conditions. Sensitive to all pressures and guaranteed to be absolutely correct when shipped. May be used for gases or liquids which do not attack brass. Range is 0 to 100 pounds per square inch with an accuracy of $\pm 1/2\%$ full scale. Made entirely of brass with 3" dial. Supplied with stopcock, threaded for 1/4" IPS connection, and nipple for attaching hose.

No. 94025

\$43.50

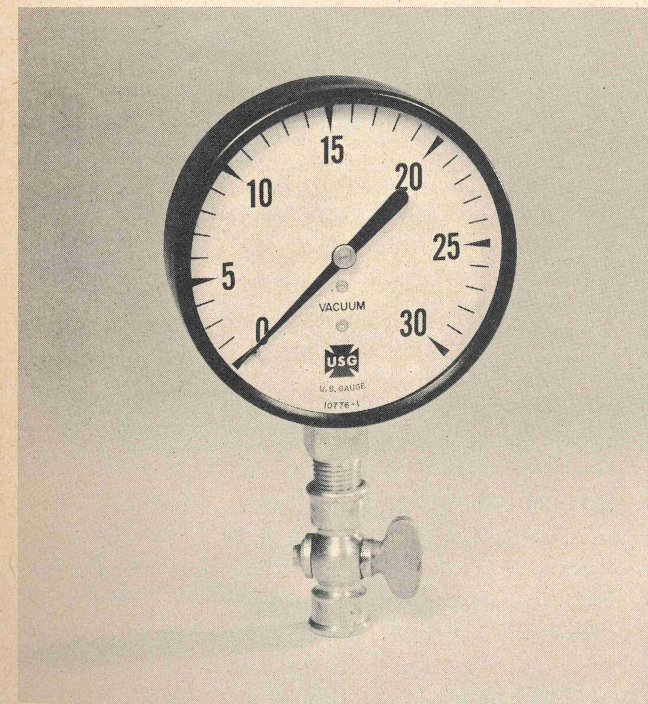


COMBINATION PRESSURE AND VACUUM GAGE

Combines both pressure and vacuum on one dial. 0-30 pounds pressure and 0-30 inches vacuum may be measured. A 3 1/2" dial is enclosed in a black steel case. Supplied with stopcock, threaded for 1/4" IPS connection and nipple for attaching hose.

No. 94035

\$9.35

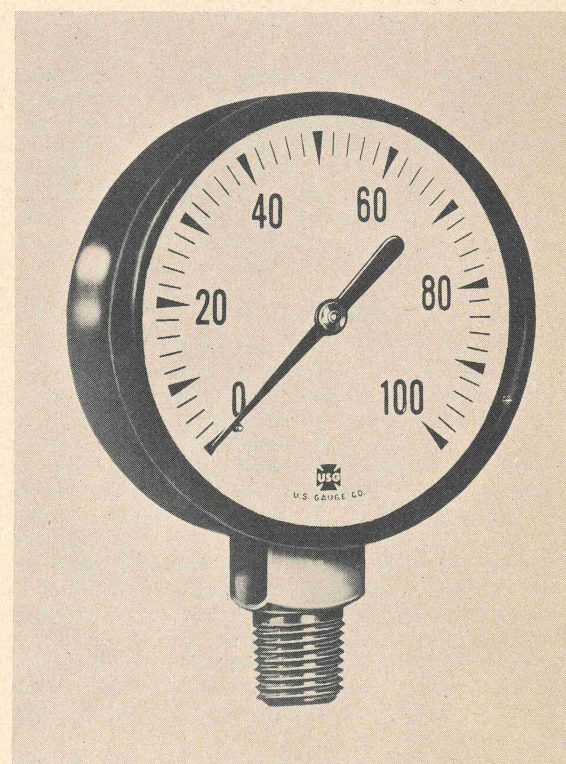


VACUUM GAGE, COMMERCIAL

Improved single spring form with a range of 0 to 30 inches and an accuracy of $\pm 2\%$. Easy-to-read 3 1/2" dial is enclosed in black finished metal case. Supplied with stopcock, threaded for 1/4" IPS connection, and nipple for attaching 3/8" hose.

No. 94030

\$8.50



PRESSURE GAGE, COMMERCIAL

Improved single spring form for air, steam or water pressure with a range from 0 to 100 pounds per square inch. Accuracy of $\pm 2\%$. Easy-to-read 3 1/2" dial in black finished iron case. Supplied with stopcock and nipple for attaching hose.

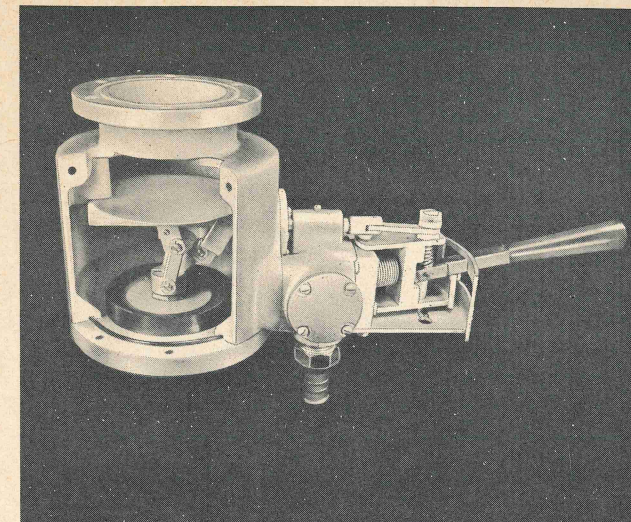
No. 94020

\$8.00



CENTRAL SCIENTIFIC COMPANY

CENCO THREE-WAY VACUUM VALVE



Flow Passages. All passages provide full pipe area throughout. Throat openings for the main valve are 4 inches in diameter. Passages for the foreline and roughing line are equivalent to 1 inch pipe.

Outgassing. Minimum outgassing time is required as only materials with low vapor pressure are used for seals. Special attention has also been given in construction to eliminate "virtual leaks."

Vacuum Tightness. The valve body and end plates are cast of close grained aluminum and vacuum impregnated after machining to assure tightness. Metallic bellows are used to seal the two movable links and rubber rings are employed at the fixed joints. The three valve disks consist of metal plates with integrally molded rubber sealing lips.

Designed to serve as a master control in high vacuum systems employing a diffusion pump and a mechanical pump. It replaces the roughing, foreline and high vacuum valves now being used in conventional systems. With this valve, the evacuated chamber may be quickly isolated from and connected back into the pumping system without shutting down the pumps. Rapid single lever action facilitates positive mechanical switching to each of three operating positions: "Closed," "Rough Down," and "Diffusion Pump." This direct mechanical movement eliminates problems associated with solenoid operated and hydraulic or pneumatic mechanisms. A water-cooled baffle is included to minimize back-streaming from the diffusion pump. The control lever extends 6" beyond the detent mechanism to provide convenient operation when the valve is mounted beneath a large baseplate or behind a panel.

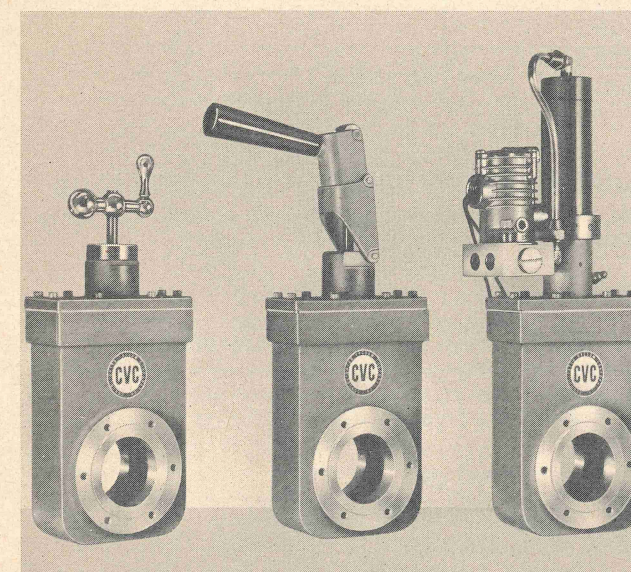
Connections. Six 1 3/8" diameter holes equally spaced on 5 1/4" diameter bolt circle are provided to attach the valve to a pump plate. To connect a diffusion pump, six 3/8-24 UNF x 1/2" deep holes equally spaced on 5 1/4" diameter bolt circle are provided. Foreline and roughing lines are connected on two nipples for 1" I.D. rubber hose. Connect nipple 90° elbow to diffusion pump outlet and straight nipple to mechanical pump. To connect the water lines, rubber tubing or ordinary 3/8" diameter copper tubing with compression type fittings may be used. The valve cooling coil may be connected in series (but in front of) the cooling coil on the diffusion pump or to an individual water source. Shipping weight is 35 lbs.

No. 94552

\$595.00

GATE VALVES

Made with high density, non-porous aluminum bodies melted and cast under vacuum to assure maximum in-leakage and out-gassing and permit use in the range of 10^{-8} torr without baking. All models feature full-opening valves with oversize, unobstructed passages having a minimum flow path to increase capacity and reduce pump-down time. The valve plate is guided by rollers and connected to a follower carriage by hinged links to eliminate scuffing on opening or closing the valve. All types feature a new ungrooved flange suitable for use with soft metal gaskets (unless the connecting flange is aluminum) or with Buna-N "O" rings held in an aluminum retainer. Valves are available in three nominal sizes (2-inch, 4-inch and 6-inch). Each size is available with either manual-operated throttling operation, quick-operating manual throttle or with pneumatic operation. Pneumatic types require an air supply of 40-60 PSIG and operate on 115 volts, 60 cycle ac.



FLANGE SPECIFICATIONS	2-Inch	4-Inch	6-Inch
O.D., inches	4	9	11
I.D., inches	2 1/4	5 1/4	7
Bolt circle, inches	3 3/8	7 1/2	9 1/2
No. of holes	6	8	8
Hole size	1/4-20 NC	5/8-11 NC	3/4-10 NC

CENCO NO.	NOMINAL SIZE & TYPE	EACH
94560-1	2-Inch Hand-Operated Throttling	\$139.00
94560-2	2-Inch Hand-Operated Toggle	132.00
94560-3	2-Inch Pneumatic	220.00
94561-1	4-Inch Hand-Operated Throttling	250.00
94561-2	4-Inch Hand-Operated Toggle	275.00
94561-3	4-Inch Pneumatic	375.00
94562-1	6-Inch Hand-Operated Throttling	360.00
94562-2	6-Inch Hand-Operated Toggle	410.00
94562-3	6-Inch Pneumatic	525.00

CENTRAL SCIENTIFIC COMPANY



ANGLE VALVES

Cenco stocks a wide variety of high vacuum angle valves for use in systems where 90° connections and vacuum-tight seals are required. All types are made with high-quality, forged brass bodies having machined seats. The valve discs are machined from solid brass bar stock and utilize a replaceable "O" ring retained in an inverted V-shaped groove. Bellows are fabricated from brass alloy and are designed to eliminate the need for packing glands. Valves are available with two types of manual actuators or with pneumatic-solenoid control and with either female pipe thread ports or with female solder joint ports for tubing. All types are guaranteed to be leak-tight and will seal against high vacuum on either port with atmospheric pressure on the opposite port.



ANGLE VALVES WITH PNEUMATIC-SOLENOID CONTROL

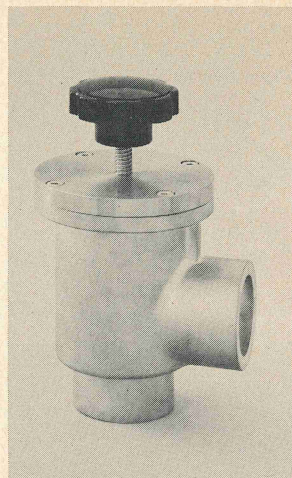
For automatic and remote operation. Includes a conduit connection that can be rotated through 360° and an air inlet that can be oriented through 360° in 90° increments. An air line pressure of 60-125 PSIG is required for operation. The solenoid operates on 115 volts, 60 cycle ac.

WITH FEMALE PIPE THREAD PORTS

CAT. NO.	PIPE THREAD	OVERALL HEIGHT	OVERALL DIAMETER	EACH
94608-1	1/2 NPTF	8"	3 1/8"	\$58.00
94608-2	3/4 NPTF	9 1/4"	3 7/8"	65.00
94608-3	1 NPTF	9 1/4"	3 7/8"	65.00
94608-4	1 1/4 NPTF	10 5/8"	4 3/4"	88.00
94608-5	1 1/2 NPTF	10 5/8"	4 3/4"	88.00

WITH FEMALE SOLDER JOINT PORTS

CAT. NO.	FOR TUBE O.D. (INCHES)	OVERALL HEIGHT	OVERALL DIAMETER	EACH
94609-1	5/8	8"	3 1/8"	\$58.00
94609-2	3/4	8"	3 1/8"	58.00
94609-3	7/8	9 1/4"	3 7/8"	65.00
94609-4	1 1/8	9 1/4"	3 7/8"	65.00
94609-5	1 3/8	10 5/8"	4 3/4"	88.00
94609-6	1 5/8	10 5/8"	4 3/4"	88.00



ANGLE VALVES WITH RISING STEM ACTUATORS

Made with a manually-operated, rising stem actuator having double Acme threads.

WITH FEMALE PIPE THREAD PORTS

CAT. NO.	PIPE THREAD	OVERALL HEIGHT (OPEN)	BODY DIAMETER	EACH
94604-1	1/2 NPTF	5 1/8"	3 1/8"	\$28.00
94604-2	3/4 NPTF	6 1 1/16"	3 7/8"	35.00
94604-3	1 NPTF	6 1 1/16"	3 7/8"	35.00
94604-4	1 1/4 NPTF	7 7/16"	4 3/4"	44.00
94604-5	1 1/2 NPTF	7 7/16"	4 3/4"	44.00

WITH FEMALE SOLDER JOINT PORTS

CAT. NO.	FOR TUBE O.D. (INCHES)	OVERALL HEIGHT (OPEN)	BODY DIAMETER	EACH
94605-1	5/8	5 1/8"	3 1/8"	\$28.00
94605-2	3/4	5 1/8"	3 1/8"	28.00
94605-3	7/8	6 1 1/16"	3 7/8"	35.00
94605-4	1 1/8	6 1 1/16"	3 7/8"	35.00
94605-5	1 3/8	7 7/16"	4 3/4"	44.00
94605-6	1 5/8	7 7/16"	4 3/4"	44.00

ANGLE VALVES WITH LEVER ACTUATORS

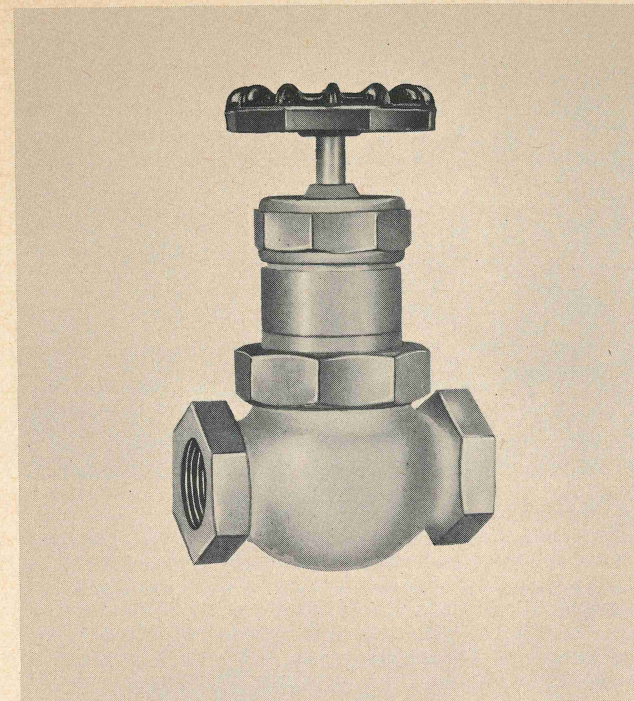
Made with a manually-operated lever actuator that opens or closes the valve with a single 190° movement.

WITH FEMALE PIPE THREAD PORTS

CAT. NO.	PIPE THREAD	OVERALL HEIGHT DURING OPENING	BODY DIAMETER	EACH
94606-1	1/2 NPTF	8 3/16"	3 1/8"	\$30.00
94606-2	3/4 NPTF	9 1/2"	3 7/8"	37.00
94606-3	1 NPTF	9 1/2"	3 7/8"	37.00
94606-4	1 1/4 NPTF	10 3/16"	4 3/4"	46.00
94606-5	1 1/2 NPTF	10 3/16"	4 3/4"	46.00

WITH FEMALE SOLDER JOINT PORTS

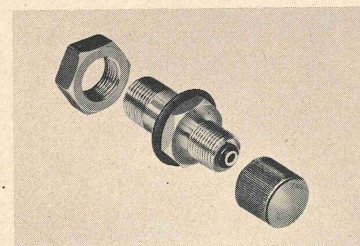
CAT. NO.	FOR TUBE O.D. (INCHES)	OVERALL HEIGHT DURING OPENING	BODY DIAMETER	EACH
94607-1	5/8	8 3/16"	3 1/8"	\$30.00
94607-2	3/4	8 3/16"	3 1/8"	30.00
94607-3	7/8	9 1/2"	3 7/8"	37.00
94607-4	1 1/8	9 1/2"	3 7/8"	37.00
94607-5	1 3/8	10 3/16"	4 3/4"	46.00
94607-6	1 5/8	10 3/16"	4 3/4"	46.00



SYLPHON PACKLESS HIGH VACUUM VALVES

With special seat for use in high vacuum systems where part of the system must be occasionally exposed to the atmosphere. A "Teflon" disk valve with stem enclosed in metallic sylphon-type bellows prevents the entrance of air through the valve stem bushings. Connections are made with standard pipe of appropriate size.

CENCO NO.	CONNECTION SIZE	OVER-ALL HEIGHT	LENGTH BETWEEN CONNECTIONS	EACH
94551-1	1"	7 7/16"	4 1/4"	\$61.00
94551-2	1 1/2"	8 1/4"	4 25/32"	77.00

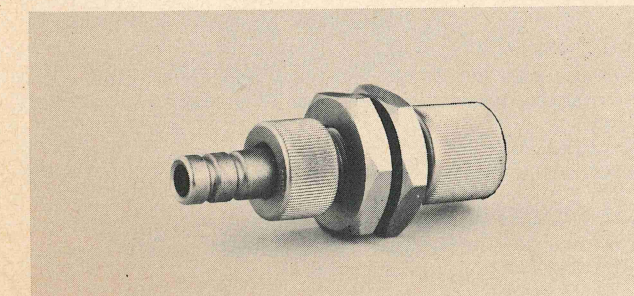


VACUUM RELEASE VALVE

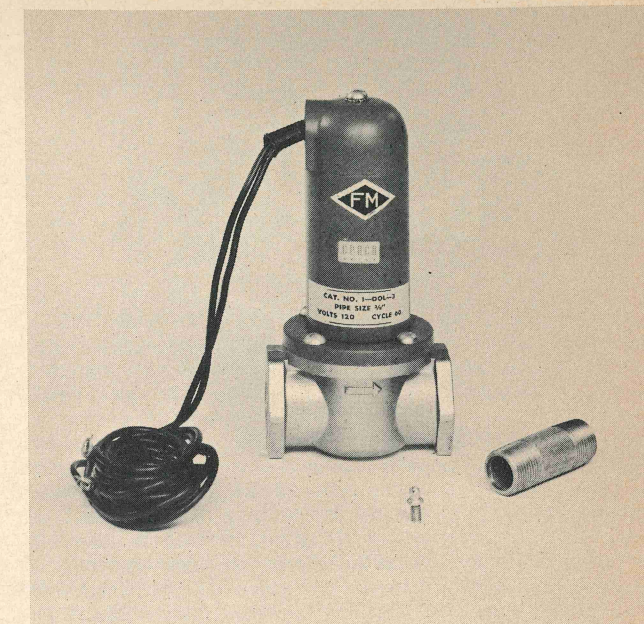
For conveniently admitting air or gases into a bell jar without disturbing pumping operations. Mounts through pump plate or system boss up to 3/4 inch thick. Machined of aluminum alloy and provided with "O" ring seals.

No. 94271

\$4.95



VALVES



LOW PRESSURE SOLENOID VALVE

For use on the intake port of Cenco Vacuum Pumps to automatically close off the evacuated system when the motor is stopped. The bodies are of aluminum finished in blue-gray hamertone, with stainless steel valve seat and armature pilot plunger. Valve diaphragm is of special synthetic rubber which withstands temperatures to 180°F. The rim of the diaphragm serves as a gasket, assuring correct alignment of assembly. Holding power consumption is 10 watts. Maximum operating range 15 lb./sq. in. Supplied with proper size close nipple to attach the valve to the pump intake after the regularly supplied nipple or coupling has been removed. No. 93062 Vacuum Sealing Compound should be used to seal the threads at the pump connection and the nipple or the coupling at the top of the valve.

Nine sizes available. Size 1 is for Cenco Hyvac-2 Pump. Sizes No. 2 and 3 for Cenco Hyvac, Hyvac-7, Pressovac, Megavac Pumps. Sizes No. 4 and 5 for Cenco Hyvac-14, Hypervac-23 and Hypervac-25 Pumps. Sizes No. 6 and 7 for Hyvac-28. Sizes 10 and 11 for Hyvac-45.

CENCO NO.	IPS THREAD, INCHES	VOLTS	CYCLES	EACH
94280-1	3/8	115	50/60	\$23.75
94280-2	1/2	115	50/60	25.25
94280-3	1/2	230	50/60	26.00
94280-4	3/4	115	50/60	26.50
94280-5	3/4	230	50/60	27.50
94280-6	1	115	60	38.50
94280-7	1	230	60	39.50
94280-10	1 1/2	115	60	48.50
94280-11	1 1/2	230	60	50.00

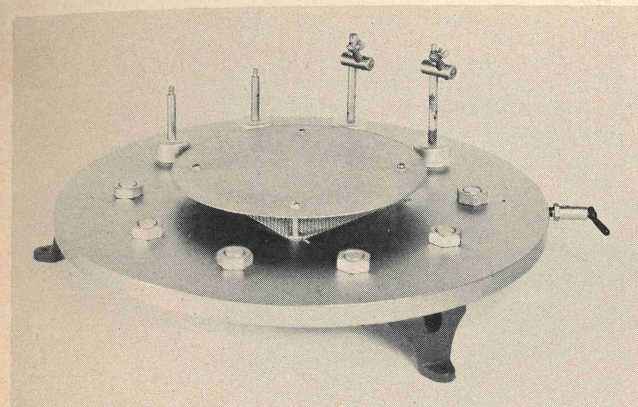
CENCO UNIVERSAL VACUUM RELEASE VALVE

A patented valve that provides a fast and convenient means of admitting air to vacuum systems. The valve may be connected by welding, brazing or soldering to the metal tubing of the vacuum system. It can be mounted on a panel or through a plate. For panel mounting the valve is inserted into a 25/32 inch hole and secured by the lock nut provided. Will fit panels up to about 1/8 inch. For plate mounting, a 5/8-18 threaded hole is required.

No. 94270

\$8.50

CENCO PUMP PLATES



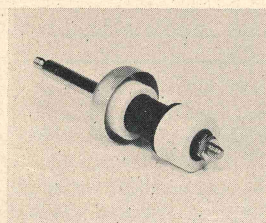
CENCO 19-INCH PUMP PLATE

Designed for use as an integral part of a vacuum system. Ideal for experimental vacuum evaporating and sputtering of metals, vacuum melting of metals and vacuum impregnation. The pump plate provides a support for a bell jar, serves as a connecting surface between the bell jar and the pumping system, has a 10" diameter platform for materials or equipment to be placed under vacuum and provides a means for connecting vacuum gage tubes and electrical power to the vacuum system. The nickel-plated, precision ground pump plate is 19" in diameter and will accept a No. P61011 Aluminum Bell Jar or a No. 94217 Pyrex Bell Jar. The central opening is 4" in diameter and is covered by a screen. A toggle-type vacuum release valve is located on the side of the plate. Three metal legs raise the plate 2" above the table surface.

Ten 3/4" diameter holes are drilled for feed-throughs and accessories. The feed-through electrodes are rated up to 5000 volts, 60 cycle and are used as filament electrodes, high voltage electrodes or to make electrical connections to equipment inside the vacuum chamber. Two filament holding clamps are drilled for mounting on the electrode arms at a 45° upward or downward angle. Will carry an intermittent current of 150 amperes at 12 volts. Ceramic insulators of the electrodes are protected against surface coatings by cups on top of the conductor studs. Supplied with the plate are four feed-through electrodes and six plugs. The plugs may be removed for the installation of additional electrodes or accessory vacuum gage ports.

A vacuum gage port can be installed for measurements of pressure within the vacuum chamber. Six holes on the underside of the plate allow direct connection to a Cenco No. 93245-1 or 93246 Diffusion Pump or a Cenco No. 94552 Three-Way valve. No. P-67544 flange can be attached to the bottom of the pump plate permitting direct connection to a mechanical vacuum pump. With a No. P67551 flange (not supplied), the pump plate may be connected directly to the Cenco Supravac OD-25 Oil Diffusion Pump.

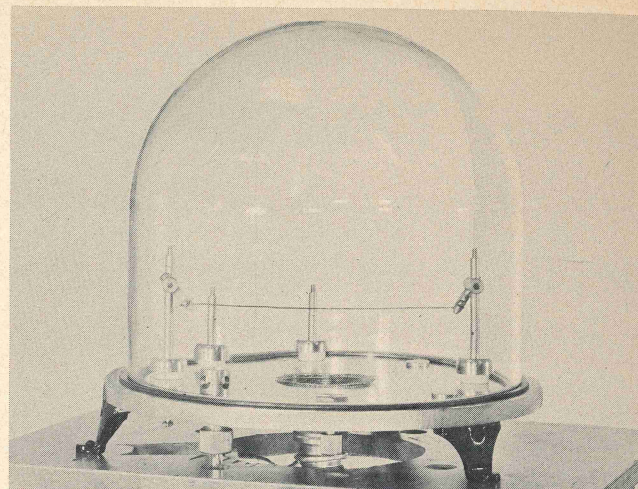
No. 94209 \$159.00
No. P67544, flange for mechanical pump 30.00
No. P67551, flange for diffusion pump 35.00



ELECTRODE FEED-THROUGH

Replacement for No. 94206 and 94209 Pump Plates. Complete with protection cup, nickel-plated rod with internal and external threads, 2 3/8" long by 3/8" diameter.

No. 94207 \$8.50



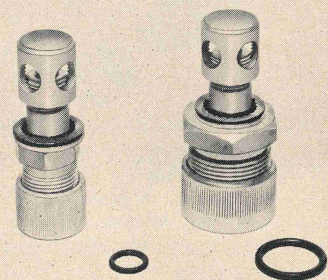
CENCO 17-INCH PUMP PLATE

An excellent pump plate for experimental vacuum evaporating and sputtering of metals, vacuum melting of metals and vacuum impregnating. May also be used for small quantity production applications. Made of cold rolled steel and nickel-plated, the pump plate is 17" in diameter with eight holes for feed-throughs and accessories. The central opening is 3-9/16" in diameter and is covered by a screen.

Eight 3/4" diameter holes are drilled through the plate for installation of four feed-through electrodes, one vacuum release valve and three plugs. The plugs may be removed to install additional electrodes, vacuum release valves or accessory vacuum gage ports. The four feed-through electrodes are rated up to 5000 volts, 60 cycle and holding clamps are drilled for setting a 45° upward or downward angle. Will carry an intermittent current of 150 amperes at 12 volts. Ceramic insulators are protected against surface coatings by cups on top of the conductor studs.

Two models are available. Type No. 1 plate is designed to connect directly to a mechanical pump such as the Hyvac 28 or Hyvac 14. Type No. 2 is supplied with a flange plate with sleeve and nut connection fitting for a diffusion pump such as the Cenco Supravac OD-25. The pump plate will accept a No. 94221-1 Aluminum Bell Jar or a No. 94214 Pyrex Bell Jar.

No. 94206-1, with flange for mechanical pumps \$171.00
No. 94206-2, with flange for Cenco Supravac OD-25 diffusion pump 171.00



GAGE PORTS

For use with No. 94206 and No. 94209 Pump Plates. Two sizes available for coupling to 1/2" or 1" diameter glass or metal tubing.

No. 94231, 1/2" \$14.25
No. 94232, 1" 15.00

GASKETS

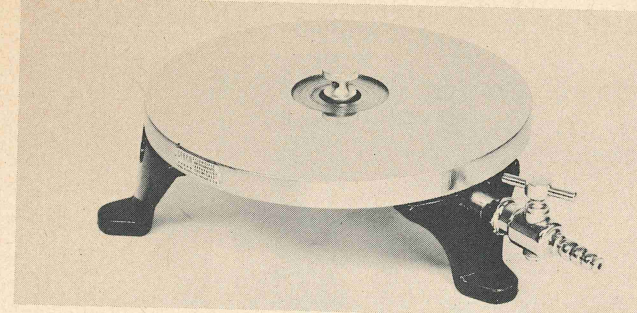
Replacement for No. 94206 and 94209 Pump Plates.

No. 94208-2, bolt type, pkg. of six \$3.35



CENTRAL SCIENTIFIC COMPANY

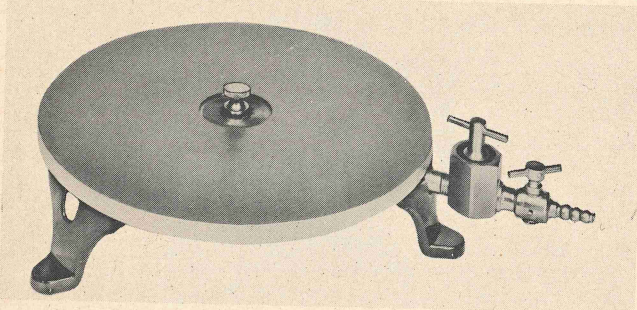
CENCO PUMP PLATES



AIR PUMP PLATE, STEEL

For use in exhausting bell jars by means of a vacuum pump. A hot-rolled steel plate, 7 7/8" (20 cm) in diameter, is ground plane to minimize danger of leakage and provided with a brass stopcock with serrated tubing connection. The vent hole at the center is tapped (7/16-16) for air pump accessories and provided with a guard plug. For use with bell jars up to 6" (15 cm) inside diameter.

No. 94200 \$36.25



AIR PUMP PLATE, STEEL

A larger version of the No. 94200 Plate for bell jars up to 9" (23 cm) inside diameter. Diameter of the plate is 10 3/4" (27 cm). Equipped with internal and external vents and brass stopcock with serrated tubing connection. The internal vent is provided with a removable guard plug and the external vent with a solid plug which may be removed for a No. 94105 Manometer. Precision ground plane and white-plated.

No. 94205 \$41.00



HIGH POTENTIAL DC POWER SUPPLY

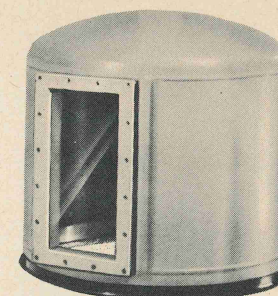
A source of high voltage for judging the vacuum in a bell jar by noting the character of the discharge. May also be used for cleaning purposes and sputtering of metal.

No. 79572 \$110.00

CENTRAL SCIENTIFIC COMPANY



CENCO BELL JARS

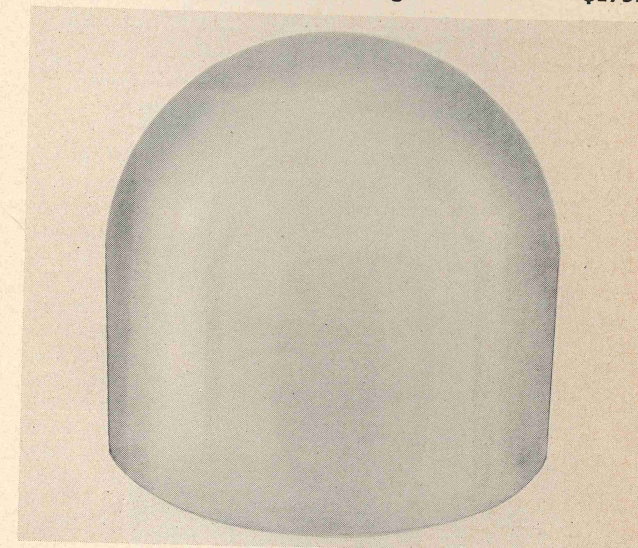


ALUMINUM BELL JARS

Protect laboratory personnel with a Cenco implosion proof aluminum bell jar. A single piece spun housing 3/16" thick has a large rectangular plastic window 10-13/16" high and 5 1/2" wide for viewing interior chamber. Five models available complete with specially formed gasket.

No. 94221-1, 15" diameter, 18" high \$149.50
No. 94221-2, 15" diameter, 15" high 139.50
No. 94223-1, 18" diameter, 18" high on request
No. 94223-2, 18" diameter, 24" high on request
Replacement bell jar for No. 94700 Vacuum Coater and Metallizer.

No. P61011, 18" diameter, 18" high \$179.50



PYREX BELL JARS — TWO SIZES AVAILABLE

A finely ground rim assures a tight seal with the pump plate. For vacuum evaporation and many other applications. Minimum wall thickness is 5/16". The smaller size may be used with Cenco Pump Plate No. 94206. The larger bell jar fits No. 94209 pump plate.

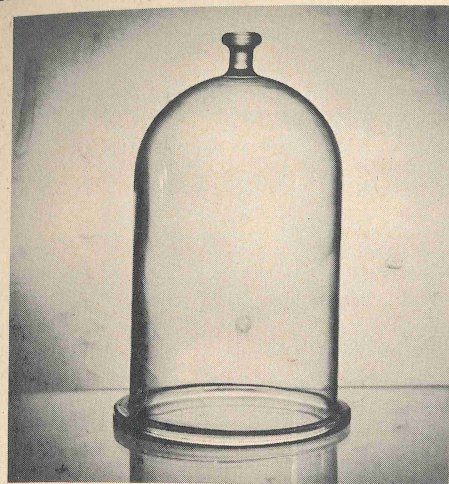
No. 94214, 14" high, 15 3/8" diameter \$74.50
No. 94217, 18" high, 18" diameter 85.00

BELL JAR GASKET

A circular, synthetic rubber gasket of "L" shape cross section for creating a vacuum-tight connection between the bell jar and pump plate. Can be cemented to the side of the bell jar without affecting the efficiency of the vacuum seal. Durometer: 60 ± 5.

CENCO NO.	O.D., INCHES	FOR PUMP PLATES	FOR BELL JARS	EACH
P27164	17 3/4	94209	94217 94223-1 94223-2 P61011	\$15.00
P27188	14 3/4	94206	94214 94221-1 94221-2	\$13.50

BELL JARS

PYREX GLASS BELL JARS,
STRAIGHT FORM KNOB, 6885

Similar in design to No. 14300 Jar, but made of Pyrex Brand glass. Number in original case, two.

CENCO NO.	OUTSIDE HEIGHT	OUTSIDE DIAMETER	CAPACITY	EACH
14302-1	9 inches	5½ inches	½ gallon	\$16.23
14302-2	10 inches	6½ inches	1 gallon	22.72
14302-3	15 inches	8¾ inches	3 gallons	31.08

STOPPERED TOP GLASS BELL JARS,
HIGH STRAIGHT FORM

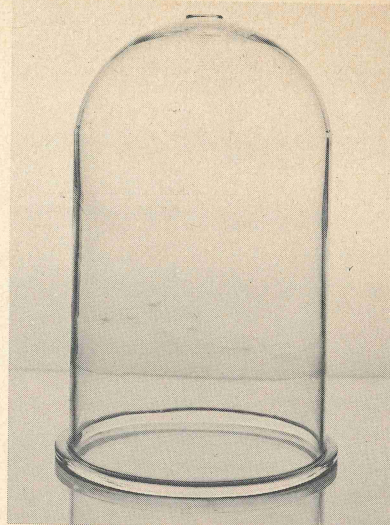
Same as No. 14305 jars but with glass stopper in the top.

CENCO NO.	INSIDE HEIGHT	INSIDE DIAMETER	CAPACITY	EACH
14315-1	9 inches	5 inches	½ gallon	\$12.00
14315-2	11 inches	6 inches	1 gallon	18.00
14315-3	15 inches	8½ inches	3 gallons	34.75

CENCO BELL JAR GUARDS

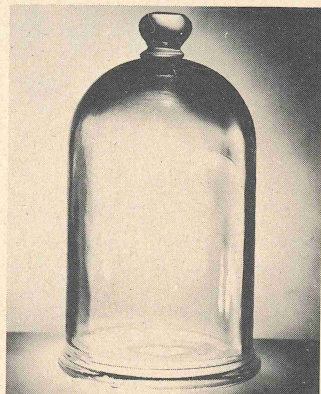
For use over Pyrex Bell Jars to protect against implosion hazards. Consists of welded steel strap with an outer shell of expanded steel mesh and hook on top for lifting. Two sizes available. No. 94215 is for use with No. 94214 bell jar. No. 94218 is for use with No. 94217 bell jar and is supplied with a clear vinyl cover inside the outer steel mesh shell. A bracket is attached that fits the hoisting mechanism of No. 94700 Vacuum Coater and Metallizer.

No. 94215, for 94214 bell jar	\$54.50
No. 94218, for 94217 bell jar	85.00

OPEN TOP GLASS BELL JARS,
HIGH STRAIGHT FORM

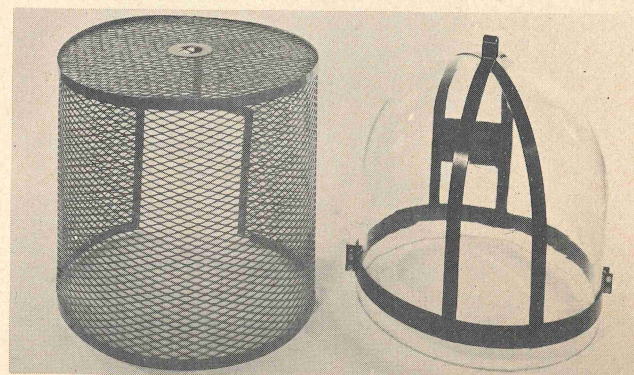
These heavy molded glass jars have an opening in the top to take a No. 4 or No. 5 rubber stopper. Hole diameter, ⅞".

CENCO NO.	INSIDE HEIGHT	INSIDE DIAMETER	CAPACITY	EACH
14305-1	9 inches	5 inches	½ gallon	\$11.00
14305-2	11 inches	6 inches	1 gallon	17.50
14305-3	15 inches	8¾ inches	3 gallons	30.00

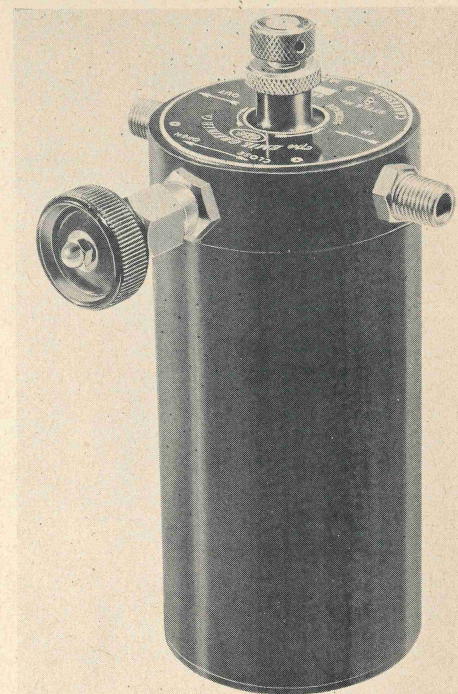
KNOB TOP GLASS BELL JARS,
HIGH STRAIGHT FORM

Formed from heavy molded glass with finely ground rims to insure a tight joint with ground glass or metal pump plates.

CENCO NO.	INSIDE HEIGHT	INSIDE DIAMETER	CAPACITY	EACH
14300-1	8½ inches	5 inches	½ gallon	\$10.00
14300-2	10 inches	6 inches	1 gallon	14.75



CENTRAL SCIENTIFIC COMPANY

VACUUM CONTROL
APPARATUS

CARTESIAN ALL-METAL MANOSTAT, NO. 8

Maintains automatic vacuum or pressure control in laboratory and industrial systems. Based on the principle of the Cartesian Diver, it has an operating range of 1 Torr* to 100 psi with an accuracy of 0.1 percent of pressure setting.

Corrosion-resistant steel and stainless steel are used in the manostat. Greater versatility of operation is provided by three interchangeable orifices. The largest orifice gives greater capacity with lower sensitivity, while the smallest is suitable for high pressure operation. A control screw permits adjustment of the orifice for the exact pressure or vacuum desired; a lock nut holds the screw at the desired adjustment. Pressure is maintained automatically by the Cartesian float, provided that the capacity of the orifice and the pump are sufficient to overcome the rate of gas flow in the system.

Over-all dimensions are 7½" high and 3¼" diameter. Supplied with three orifices and complete operating instructions. Weighs 8 pounds and requires 51 ml of mercury for one filling. No. 94625, without mercury

\$155.00

CARTESIAN ALL-GLASS MANOSTAT, NO. 7A

This improved apparatus maintains automatic vacuum control in laboratory distillations. Once a vacuum has been set in the instrument, the system may be shut down without disturbing the setting. Provides simple and fool-proof operation. Corrosion resistant, requires 12 ml of mercury for one filling. Supplied with one orifice and complete operating instructions.

No. 94621, without mercury

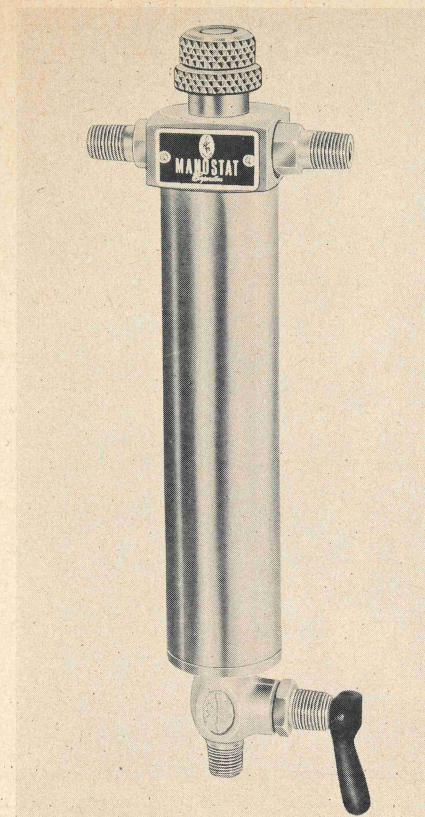
\$49.25

CENCO MERCURY

C.P., ACS Triple distilled quicksilver.

1 pound	\$12.60
5 pounds	56.50
4 ounces	4.50

15 pounds maximum quantity for parcel post shipment.



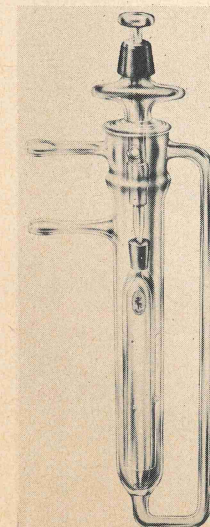
CARTESIAN MANOSTAT, NO. 6A

For maintaining automatic vacuum or pressure control in laboratory or industrial systems. While similar in principle to the No. 94625 Control, this apparatus is not quite as sensitive. This model is designed to automatically maintain a vacuum setting after the system has been shut down; this feature, however, does not apply to pressure operations. The shut-off valve must be opened before closing down a pressure system. The operating range is from 1 Torr* to 100 psi absolute pressure. All metal parts are made of stainless steel; gaskets of chemically resistant, synthetic rubber. A control screw permits adjustment of the orifice for the exact vacuum or pressure desired; a lock nut holds the screw in the desired position. A toggle valve at the bottom assures absolute tightness of the set pressure.

Over-all dimensions are 6⅞" high and 1¼" diameter. Supplied with one orifice and complete operating instructions. Weighs 1¾ pounds and requires 8 ml of mercury for one filling.

No. 94630, without mercury

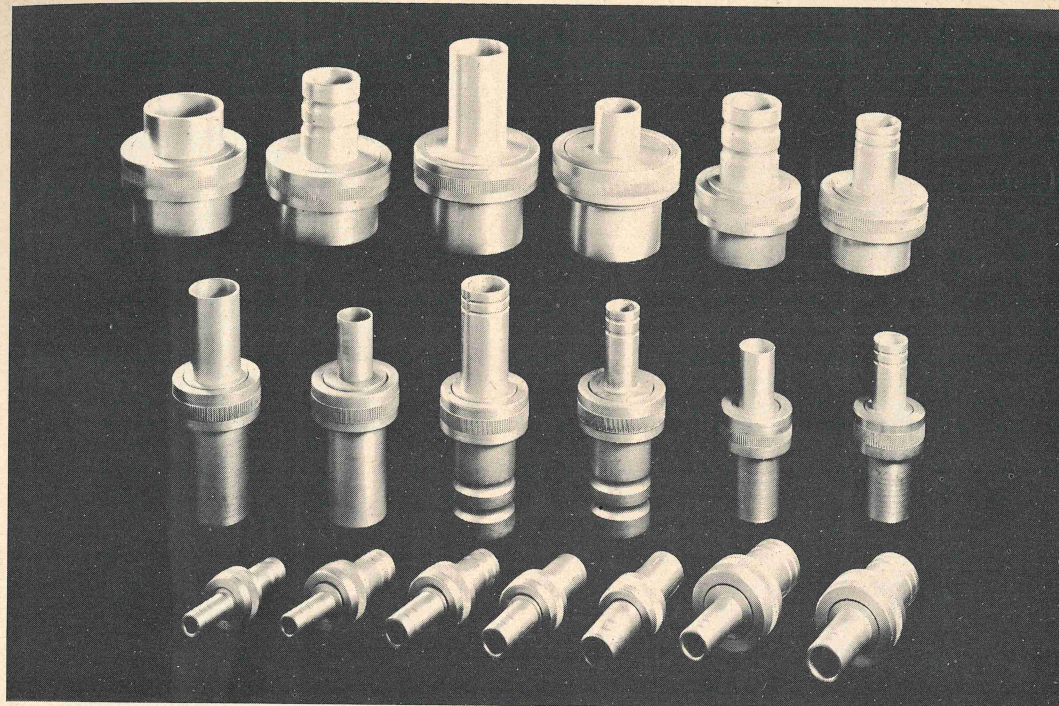
\$140.00



CENTRAL SCIENTIFIC COMPANY



VACUUM CONNECTORS AND COUPLINGS



CENCO REDUCING COUPLINGS METAL, GLASS OR RUBBER TUBING

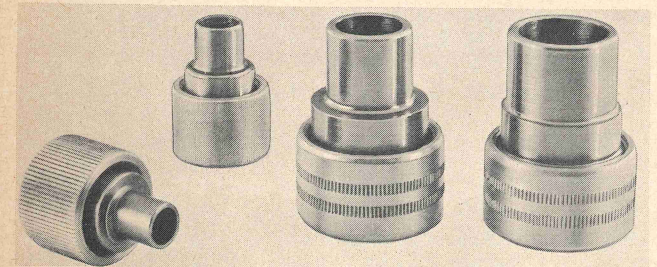
The couplings consist of 4 nickel-plated parts: main body, "O" ring, nipple and coupling nut. Intended for use with metal, glass and/or rubber tubing. The inside and outside diameters of the

main body and the sleeve of the various size couplings have been made to take standard metal or glass tubing and Cenco rubber vacuum tubing. See table for sizes and prices.

CENCO NO.	SIZE, INCHES	EACH
94238-1	$\frac{3}{8}$ to $\frac{1}{4}$	\$ 4.50
94238-2	$\frac{1}{2}$ to $\frac{1}{4}$	5.25
94238-3	$\frac{1}{2}$ to $\frac{3}{8}$	5.25
94238-4	$\frac{5}{8}$ to $\frac{3}{8}$	6.50
94238-5	$\frac{5}{8}$ to $\frac{1}{2}$	6.50
94238-6	$\frac{3}{4}$ to $\frac{3}{8}$	7.50
94238-7	$\frac{3}{4}$ to $\frac{1}{2}$	7.50
94238-8	$\frac{7}{8}$ to $\frac{1}{2}$	10.50
94238-9*	$\frac{7}{8}$ to $\frac{5}{8}$	10.50
94238-10	1 to $\frac{1}{2}$	13.50

CENCO NO.	SIZE	EACH
94238-11	1 to $\frac{3}{4}$	13.50
94238-12*	$1\frac{1}{8}$ to $\frac{5}{8}$	14.50
94238-13*	$1\frac{1}{8}$ to $\frac{7}{8}$	14.50
94238-14	$1\frac{1}{2}$ to $\frac{3}{4}$	18.50
94238-15	$1\frac{1}{2}$ to 1	18.50
94238-16*	$1\frac{5}{8}$ to $\frac{7}{8}$	19.00
94238-17*	$1\frac{5}{8}$ to $1\frac{1}{8}$	19.00
94238-18	2 to 1	19.50
94238-19*	2 to $2\frac{1}{2}$	21.50

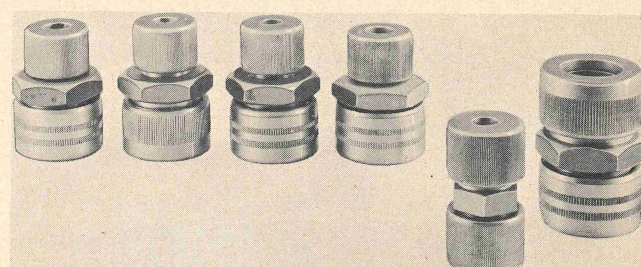
*For metal and/or glass tubing only.



CENCO CONNECTORS METAL TO GLASS TUBING

These nickel-plated brass connectors provide simple, vacuum-tight connections between metal and glass tubing at one end only. The connector body is slipped over the metal tubing and is welded, brazed or soldered to form a tight joint. Rubber "O" ring is provided. See table for sizes and prices.

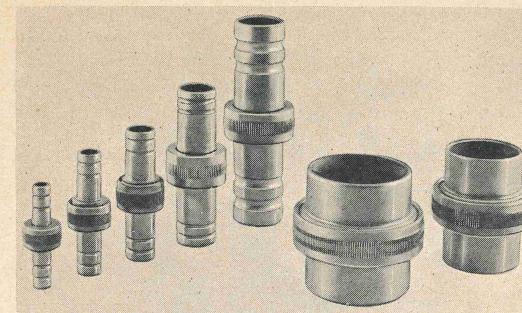
CENCO NO.	SIZE, INCHES	EACH
94230-1	$\frac{3}{8}$ to $\frac{3}{8}$	\$4.95
94230-2	$\frac{1}{2}$ to $\frac{1}{2}$	5.95
94230-3	$\frac{3}{4}$ to $\frac{3}{4}$	6.95
94230-4	1 to 1	7.95



CENCO REDUCING COUPLINGS GLASS AND/OR METAL TUBING

For use with glass and metal tubings of different sizes. Made of several separable aluminum parts and supplied with rubber "O" rings. See table for sizes and prices.

CENCO NO.	SIZE, INCHES	EACH
94228-1	$\frac{1}{2}$ to $\frac{3}{8}$	\$ 6.95
94228-2	$\frac{3}{8}$ to $\frac{3}{8}$	8.95
94228-3	$\frac{3}{4}$ to $\frac{1}{2}$	9.95
94228-4	1 to $\frac{3}{8}$	9.95
94228-5	1 to $\frac{1}{2}$	9.95
94228-6	1 to $\frac{3}{4}$	11.95



CENCO STRAIGHT-THROUGH COUPLINGS METAL AND/OR RUBBER TUBING

Consists of 4 nickel-plated parts: main body, "O" ring, nipple and coupling nut. Intended for use with metal tubing and/or rubber tubing. The inside and outside diameters of the main body and the sleeve of the various size couplings have been made to take standard metal tubing and Cenco rubber vacuum tubing. Sizes 6 and 7 are for metal tubing only. See table for sizes and prices.

CENCO NO.	SIZE, INCHES	EACH
94235-1	$\frac{1}{4}$ to $\frac{1}{4}$	\$ 4.25
94235-2	$\frac{3}{8}$ to $\frac{3}{8}$	4.50
94235-3	$\frac{1}{2}$ to $\frac{1}{2}$	5.25
94235-4	$\frac{3}{4}$ to $\frac{3}{4}$	7.50
94235-5	1 to 1	13.50
94235-6	$1\frac{1}{2}$ to $1\frac{1}{2}$	18.50
94235-7	2 to 2	19.50
94235-10	$\frac{5}{8}$	6.50
94235-11	$\frac{7}{8}$	10.50
94235-12	$1\frac{1}{8}$	13.50
94235-13	$1\frac{5}{8}$	19.00

REPLACEMENT "O" RINGS

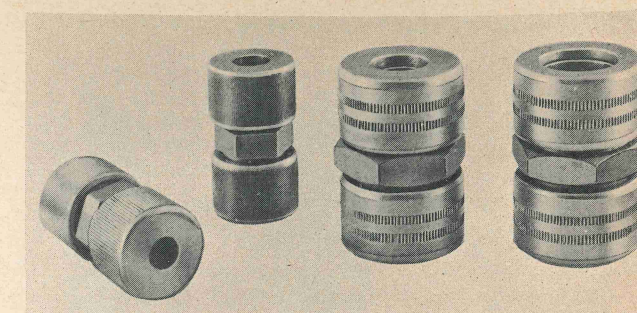
Use with Nos. 94235 Couplings, No. 94240 Caps No. 94245 Nipples. Special composition rubber for vacuum use and temperatures up to 200°F. Inside diameters shown correspond to the outside diameter sizes shown for the coupling, tubings, caps and nipples.

CENCO NO.	I.D., INCHES	O.D., INCHES	PKG. OF 12
94236-1	$\frac{1}{4}$	$\frac{3}{8}$	\$3.30
94236-2	$\frac{3}{8}$	$\frac{1}{2}$	3.30
94236-3	$\frac{1}{2}$	$\frac{1}{16}$	3.30
94236-4	$\frac{3}{4}$	1	3.90
94236-5	1	$1\frac{1}{4}$	3.90
94236-6	$1\frac{1}{2}$	$1\frac{3}{4}$	4.50
94236-7	2	$2\frac{1}{4}$	4.80

VITON "O" RINGS

Similar to No. 94236 O-Rings but made of a synthetic rubber for use in high vacuum applications where the rings will be exposed to temperatures up to 250°C (482°F). May be used intermittently to 300°C (572°F). Can be partially baked out. Sold in packages of a dozen rings.

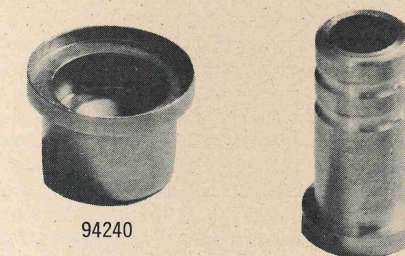
CENCO NO.	I.D., INCHES	WIDTH, INCHES	PKG.
94237-1	$\frac{1}{4}$	$\frac{1}{16}$	\$ 5.25
94237-2	$\frac{3}{8}$	$\frac{1}{16}$	5.50
94237-3	$\frac{1}{2}$	$\frac{3}{32}$	10.00
94237-4	$\frac{3}{4}$	$\frac{1}{8}$	17.50
94237-5	1	$\frac{1}{8}$	21.00
94237-6	$1\frac{1}{2}$	$\frac{1}{8}$	31.50
94237-7	2	$\frac{1}{8}$	46.00



CENCO STRAIGHT-THROUGH COUPLINGS GLASS AND/OR METAL TUBING

Especially useful for connecting vacuum gages into the system. All sizes are composed of several separable aluminum alloy parts and rubber "O" rings. See table for sizes and prices.

CENCO NO.	SIZE, INCHES	EACH
94226-1	$\frac{3}{8}$ to $\frac{3}{8}$	\$ 6.95
94226-2	$\frac{1}{2}$ to $\frac{1}{2}$	6.95
94226-3	$\frac{3}{4}$ to $\frac{3}{4}$	10.95
94226-4	1 to 1	11.95



CENCO RUBBER TUBING NIPPLE ADAPTER

For use in No. 94235 Couplings with No. 94236 "O" Rings for rubber tubing connections. Two large serrations assure a firm grip of the tubing and are recessed to receive the "O" Rings, providing a vacuum-tight seal. Made of nickel-plated brass. The size number corresponds to the same sizes of No. 94235 Couplings and No. 94236 "O" Rings.

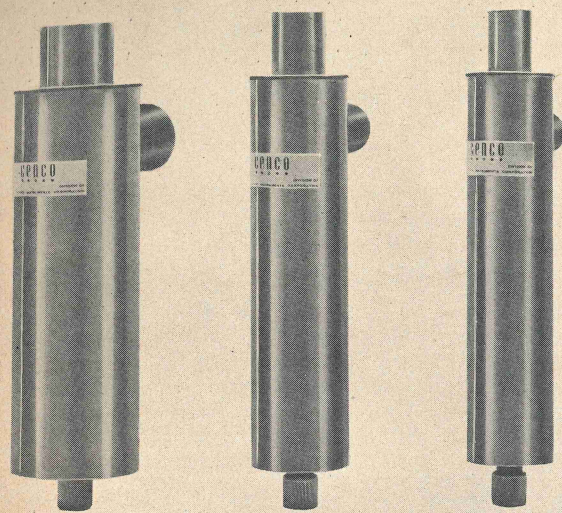
CENCO NO.	O.D., INCHES	BORE, INCHES FOR RUBBER TUBING	NO. 18204 TUBING SIZE	EACH
94245-1	$\frac{3}{8}$	$\frac{1}{4}$	3	\$1.10
94245-2	$\frac{1}{2}$	$\frac{7}{16}$	6	1.30
94245-3	$\frac{5}{8}$	$\frac{7}{16}$ to $\frac{5}{8}$	6 or 8	1.75
94245-4	$\frac{29}{32}$	$\frac{13}{16}$	11	3.00
94245-5	$1\frac{1}{16}$	$\frac{13}{16}$	11	6.25

CENCO VACUUM COUPLING CAPS

For use with No. 94235 Couplings and No. 94236 "O" Rings for closing off conducting tubes in vacuum systems. Provide convenient seals. Made of nickel-plated brass. Size numbers correspond to size numbers of No. 94235 Couplings. Without "O" Rings.

CENCO NO.	FOR TUBING O.D., INCHES	EACH
94240-1	$\frac{1}{4}$	\$1.85
94240-2	$\frac{3}{8}$	2.00
94240-3	$\frac{1}{2}$	2.00
94240-4	$\frac{3}{4}$	1.85
94240-5	1	2.10
94240-6	$1\frac{1}{2}$	4.50
94240-7	2	5.00

VACUUM SYSTEM TRAPS



CENCO LIQUID NITROGEN TRAPS

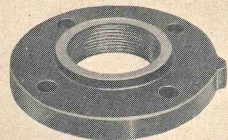
For use in vacuum systems to condense moisture and oil vapors without materially retarding system conductance. The traps consist basically of two concentric metal tubes, top and bottom plates, a vacuum cap and inlet nipple. The bottom plate has a Teflon O-ring seal to permit periodic draining of the condensate to the collector tube. From here, condensate can be emptied simply by removing the threaded cap at the bottom of the trap. In operation, the syphon tube is connected to a vacuum pump and the collection tube to the system being evacuated. Connections can be made with either rubber tubing or with metal tubing for permanent installations. A Dewar-type flask with a suitable coolant such as liquid nitrogen or a dry ice-alcohol is required to condense the vapors in the collector tube. Cenco No. 15830-4 Dewar Flask is recommended for all sizes of traps. The traps are available in a choice of welded aluminum or silver-soldered stainless steel. All types have an overall length of 12 inches and an effective trap length of 7½ inches.

SYPHON TUBE AND COLLECTOR				
CENCO NO.	MATERIAL	INTAKE NIPPLE O.D.	TUBE O.D.	EACH
94009-1	Aluminum	1"*	2"	\$44.50
94009-2	Aluminum	1¼"***	2¼"	49.50
94009-3	Aluminum	1½"***	3"	55.00
94009-4	Stainless Stl.	1"*	2"	59.00
94009-5	Stainless Stl.	1¼"***	2¼"	67.50
94009-6	Stainless Stl.	1½"***	3"	79.00

*For ¾" water tubing, 7/8" mechanical tubing or 1" rubber tubing.

**For 1" water tubing, 1½" mechanical tubing or 1¼" rubber tubing.

***For 1½" water tubing, 1½" mechanical tubing or 1¼" rubber tubing.

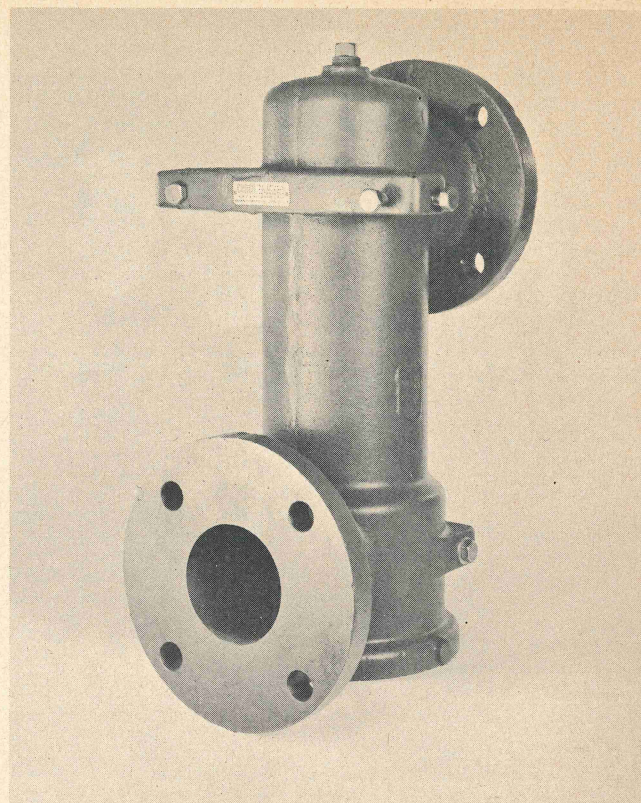


MALLEABLE IRON CONNECTING FLANGE

For connecting the No. 94002 Freezing Trap to standard iron pipe, 3" I.P.S. Over-all diameter of the flange is 7½"; it is drilled for four 5/8" bolts.

No. 94003

\$9.00

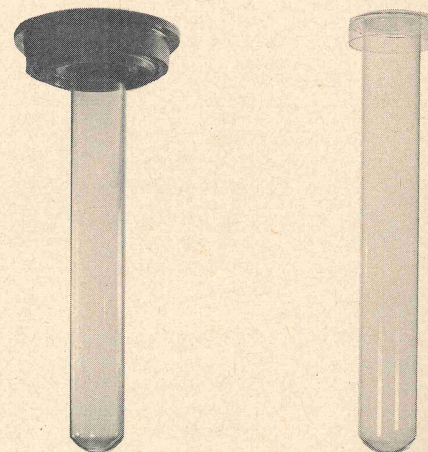


CENCO SINGLE UNIT FREEZING TRAP

For use with mechanical vacuum pumps for trapping moisture and oil vapors in high vacuum systems. It can be connected directly to the Cenco-Hypervac 100. It consists of a steel casing with flanges at both ends. The casing is large enough not to materially retard conductance. An easily removed glass tube is used to hold the freezing mixture. Baffling is provided by a metal screen within the casing. The trap is supplied complete with the glass tube but without the No. 94003 Connecting Flange for standard 3-inch iron pipe. The over-all length is 18". Face to face of flanges is 9". The height of the glass tube is 14½".

No. 94002

\$181.00



MOUNTED GLASS TUBE

No. 94004-2 Glass Freezing Tube sealed in a metal flange for replacement in the No. 94002 Freezing Trap. The metal screen is not included.

No. 94004-1

\$43.50

GLASS FREEZING TUBE

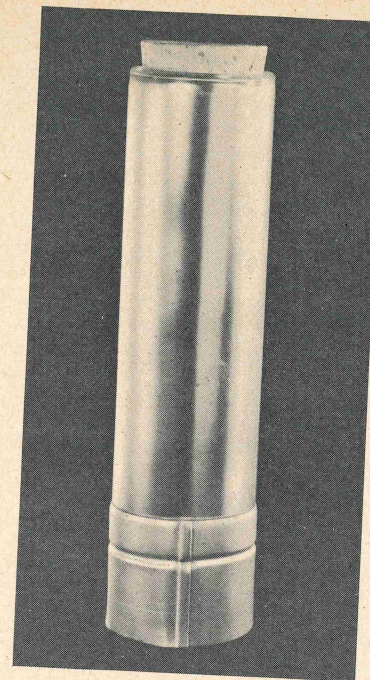
Unmounted for replacement in No. 94002 trap.

No. 94004-2

\$17.00



CENTRAL SCIENTIFIC COMPANY

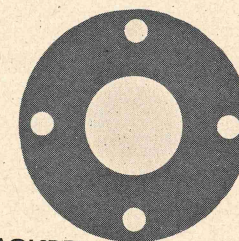


DEWAR VACUUM FLASK

For use with liquid air traps. Metal base with silvered glass body; 1000 ml capacity, 30 mm inside length, 70 mm inside diameter, made of Pyrex brand glass.

No. 15830-3

\$12.25

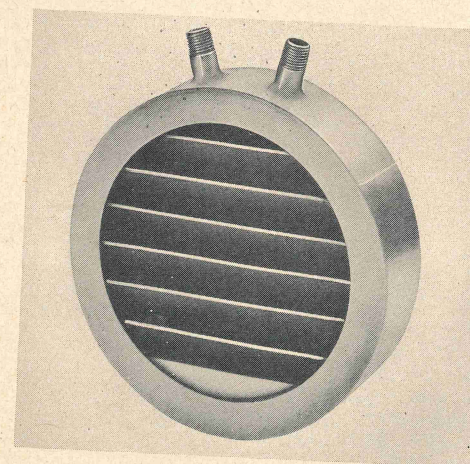


KOROSEAL GASKET

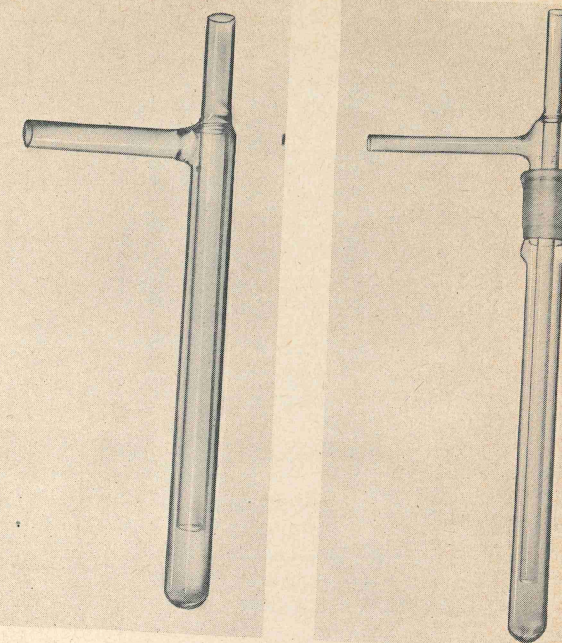
For replacement or use with Nos. 94002, 94003 and 94004-1 in sealing connections.

No. 94004-3

\$2.25



SPECIFICATIONS	Cenco No. 90011			
	-2	-4	-6	-10
Nominal size, inches	2	4	6	10
O.D., inches	3.000	6.781	8.687	13.250
I.D., inches	2.250	5.375	7.125	11.250
Thickness, inches	1.406	1.906	1.906	2.870
Water connections				
IPS, inch	1/8	1/4	1/4	1/4



GLASS LIQUID AIR TRAP

Pyrex brand glass, for either absorbing or "freezing out" vapors and gases. Most applications require only a mixture of 80% dry ice and 20% alcohol in a Cenco No. 15830-3 Vacuum Flask. Dimensions of trap: 14.5" long; 1.12" outside diameter; nipples are for ¾" (19 mm) diameter connecting tubes.

No. 94005

\$6.50

GLASS LIQUID AIR TRAP WITH TAPER JOINT

Same as above but equipped with standard taper joint for emptying the condensate.

CENCO NO.	O.D. OF TRAP (INCHES)	DIAMETER OF CONNECTING TUBES (INCHES)	EACH
94006-1	1.00	0.50	\$21.00
94006-3	1.19	0.75	23.50
94006-4	1.56	1.00	25.50

VACUUM SYSTEM BAFFLES

CENCO WATER-COOLED CHEVRON BAFFLES

For use at the inlet of a diffusion pump to condense pump fluid vapors and return the fluid to the pump. This elimination of "backstreaming" permits a system to be pumped down to a higher vacuum than is otherwise possible. All types are water-cooled, high conductance, optically-dense baffles using nickel-plated copper chevron brazed into a stainless steel ring having provision for circulation of cooling water. The baffles are of correct size to fit into the bolt circle of mating component flanges; therefore, no bolt holes are necessary in the baffle. Contacting surfaces are machined flat with one surface grooved for an "O" ring which is supplied. Complete with standard IPS male thread water cooling connections. All types are suitable for ultra-high vacuum applications.

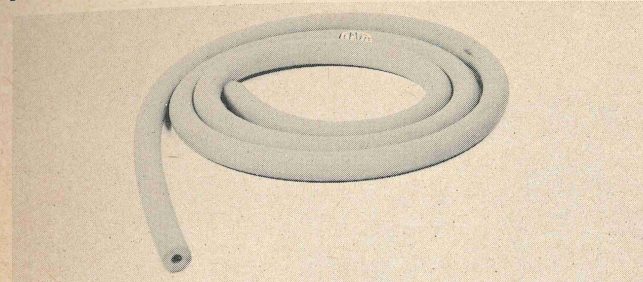
ORDERING GUIDE

CENCO NO.	NOMINAL SIZE	EACH
90011-2	2 Inches	\$198.00
90011-4	4 Inches	280.00
90011-6	6 Inches	425.00
90011-10	10 Inches	775.00



CENTRAL SCIENTIFIC COMPANY

RUBBER VACUUM TUBING

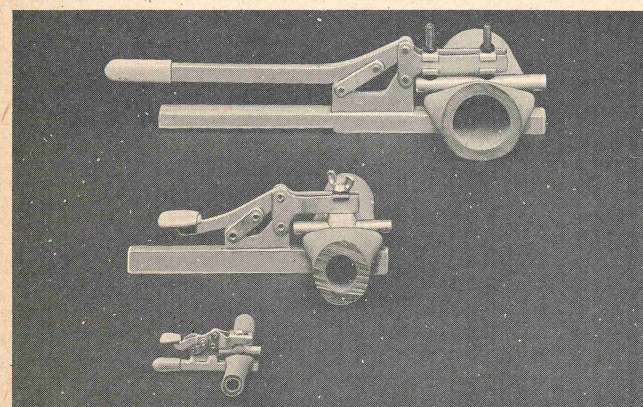


CENCO EXTRA HEAVY WALL RUBBER TUBING

For filter and vacuum pump connections, mercury leveling bulbs, etc. Made for high vacuum work from a special Cenco formula. Sold in 5 foot lengths.

CENCO NO.	I.D. INCHES	WALL THICKNESS INCHES	PER FOOT
18204-1	1/8	3/32	\$0.30
18204-2	3/16	3/16	0.48
18204-3	1/4	3/16	0.54
18204-6	7/16	5/16	1.05
18204-8	5/8	3/8	1.50
18204-11	13/16	3/8	1.70

CLAMPS FOR TUBING

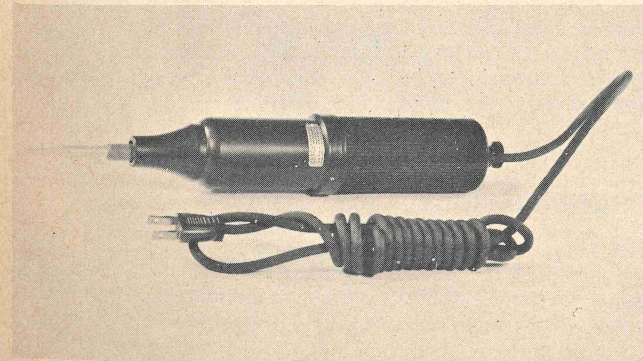


HOSE CLAMPS

Heavy duty clamps of cast metal for closing off vacuum tubing. Jaws are easily opened by a hand grip. Three sizes are available. All are adjustable to fit various sizes of vacuum tubing.

CENCO NO.	USE WITH RUBBER TUBING	EACH
12196-1	NO. 18204-3 (5/8" OD) or smaller	\$ 6.00
12196-2	NO. 18204-6 (1 1/8" OD) to -11 (1 1/2" OD)	9.00
12196-3	Sizes above 1 1/2" OD	15.00

HIGH FREQUENCY COIL



LARGE SIZE EXTRA HEAVY WALL RUBBER TUBING

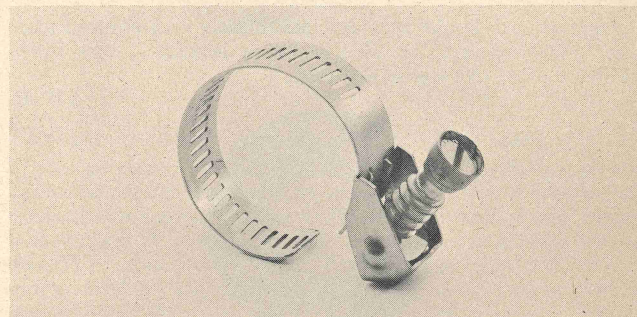
Larger sized, specially made rubber tubing for high vacuum flexible connections between mechanical pumps and vacuum components. Hand made from pure red rubber. Sold only in lengths of 5 feet or more. All tubing has a 3/8" wall except No. 2 which has a 3/16" wall.

CENCO NO.	I.D., INCHES	PER FOOT
18205-2	5/16	\$0.50
18205-7	1/2	1.40
18205-10	3/4	1.95
18205-12	1	2.05
18205-13	1 1/8	2.40
18205-14	1 3/8	2.85
18205-15	2 1/8	3.60

AMBER, EXTRA HEAVY WALL RUBBER TUBING

Made of latex rubber virtually free from volatile impurities. Produces a better vacuum seal because of high adhesion factor for smooth surfaces such as glass and metal tubing. For filter and vacuum connections. Bore is 5/16 inches; wall thickness is 3/16 inches. Stocked in 50 feet per box or sold in 5 foot lengths.

No. 18253, per foot \$0.40



"SNAP-LOCK" HOSE CLAMPS

Provide rapid, effective clamping of rubber tubing connections. A special worm-drive screw permits quick placing or removal of the clamp. The clamp opens completely so that it may be installed at any location on the tubing. Once tightened, the screw cannot be pried off. These unique clamps hold under severe vibrations and will not tear or cut rubber tubing. Made of corrosion-resistant, stainless steel.

CENCO NO.	TUBING O.D.		EACH
	MIN., INCHES	MAX., INCHES	
12178-1	1/2	1 1/4	\$0.33
12178-2	1	1 3/4	0.34
12178-3	1 1/2	2 1/4	0.35
12178-4	2	2 3/4	0.37

For testing vacuum assemblies for leakage. Consists of a high frequency coil of the Tesla type with one terminal of the secondary connected to the pointed end of the coil. The coil is mounted in a bakelite shell and is of a size and shape to fit the hand. The primary is wound for 115 volts ac or dc. In use the attachment plug is connected to a lamp socket, adjustment is made by means of the screw at the large end of the coil until a stream of high frequency sparks of 40 to 50 kv and 3-4 megacycles will pass continuously to any metal near which it is held. The coil is then moved along the vacuum line with the metal tip near the glass parts of the vacuum assembly. A leak will be plainly shown by the fact that the spark will unerringly pass through a minute hole in the glass producing a yellow glow at the location of the hole. Dimensions: Length of coil over-all, 14 inches; diameter, 2 inches; weight, 2 pounds, as described, with 6 feet of rubber covered connecting cord and attachment plug. No. 80730 \$14.50



CENTRAL SCIENTIFIC COMPANY

STANDARD WALL, PYREX BRAND 23430-510

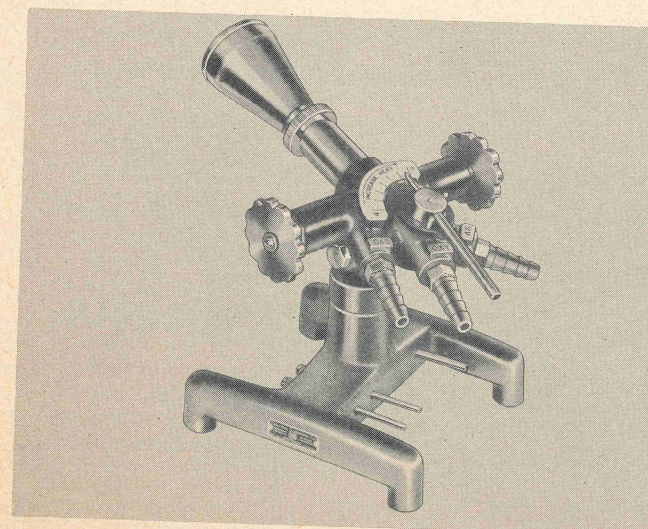
Identical in composition and coefficient of expansion with the glass used in the manufacture of Pyrex brand beakers, flasks, and other chemical ware. Because of the ease with which Pyrex brand tubing can be manipulated before the blast lamp, and its comparatively wide working range, it is particularly adapted for use by the beginner in laboratory glass blowing.

Stocked in 4 foot lengths only and unless otherwise specified, orders for less than 5 lbs. will be cut into 2 foot lengths for convenience in packing. When special lengths of less than 4 feet are ordered, a charge will be made for full 4 foot lengths. An additional charge will be made for selecting tubing of accurately gaged inside and outside measurements. Packed in cases containing 25 lbs. of one size, except for the 3 mm size, which is in a case of 15 lbs.

No. 14095

specify O.D. with No. when ordering

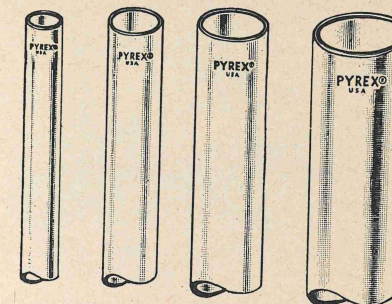
O.D., mm	TOLERANCE FOR O.D., ± mm	THICKNESS OF WALL, mm	APPROX. FT. PER LB.	PER LB.
3	0.40	0.6	147	\$2.52
4	0.40	0.8	88.3	1.66
5	0.40	0.8	62.5	1.52
6	0.43	1.0	43.5	1.52
7	0.43	1.0	35.7	1.52
8	0.45	1.0	30.3	1.52
9	0.45	1.0	26.3	1.52
10	0.46	1.0	23.8	1.52
11	0.49	1.0	21.3	1.52
12	0.50	1.0	19.2	1.52
13	0.51	1.2	15	1.52
14	0.53	1.2	14	1.52
15	0.54	1.2	12.8	1.52
16	0.54	1.2	12	1.52
17	0.56	1.2	11.2	1.52
18	0.56	1.2	10.5	1.52
19	0.58	1.2	10	1.52
20	0.65	1.2	9.4	1.52
22	0.70	1.5	7	1.52
25	0.77	1.5	6	1.52
28	0.85	1.5	5.4	1.52
30	0.90	1.8	4.2	1.52
32	0.95	1.8	3.9	1.52
35	1.07	2.0	3.2	1.52
38	1.12	2.0	2.9	1.66
41	1.14	2.0	2.7	1.66
45	1.24	2.0	2.5	1.66
48	1.24	2.0	2.3	1.66
51	1.27	2.0	2.2	1.66



CENTRAL SCIENTIFIC COMPANY



GLASS TUBING



LARGE SIZE STANDARD WALL, PYREX BRAND 234000-900

Same as No. 14095 Glass Tubing but in diameters greater than 51 mm. Stocked in 4 foot lengths only. When special lengths of less than 4 feet are ordered, a charge will be made for full 4 foot lengths. Packed in cases containing lengths of one size.

No. 14101

specify O.D. with No. when ordering

O.D., mm	TOLERANCE FOR O.D., mm	THICKNESS OF WALL, mm	APPROX. FEET PER LB.	LBS. PER CASE	PER LB.
54	1.27	2.4	1.72	9	\$1.66
57	1.27	2.4	1.62	10	1.66
60	1.37	2.4	1.54	10	1.66
64	1.50	2.4	1.43	11	1.86
70	1.50	2.4	1.31	12	1.86
75	1.60	2.4	1.22	13	1.86
80	1.63	2.4	1.14	14	1.86
85	1.63	2.4	1.07	15	1.86
90	1.65	2.4	1.01	16	1.86
100	1.77	2.4	0.9	18	1.86

LARGE SIZE, STANDARD WALL, PYREX BRAND

Same as No. 14101 Glass Tubing but sold in single 4 foot lengths only.

O.D., mm	Specify O.D. with number when ordering.									
	54	57	60	64	70	75	80	85	90	100
EACH	\$3.85	3.95	4.40	5.25	5.60	6.05	6.55	7.00	7.45	8.35

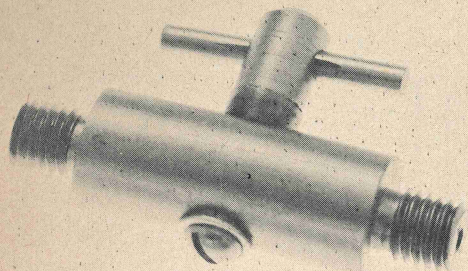
CENCO BLAST BURNER

A heavy-duty burner for use in working borosilicate glass. It is especially appreciated whenever it is necessary to prepare heavy Pyrex glass connections for use in a vacuum system. Extremely hot flames can be obtained, ranging from a short, sharp needle to a wide brush making it easy to work glass of all sizes. The burner operates on compressed air, oxygen, and gases having BTU values of 500 to 1000 and above. A convenient mixing valve and control lever regulates the mixture of air, gas, and oxygen. Provided with serrated inlet nipples for gas, oxygen, and air that will accept rubber tubing from 1/4 to 3/8 inch I.D.; two interchangeable nozzles that permit use with any type of commercial gas; and an extra-heavy H-base. Overall dimensions are 9 1/2 inches long by 5 3/8 inches wide by 6 1/4 inches high. Recommended accessories are a constant pressure regulator for connection to the high pressure oxygen supply and a large stopcock for connection to the gas line.

No. 11241 Cenco-Universal Giant Burner
No. 13910 Regulator for above
No. 18945 Stopcock for above

\$77.50
39.60
6.60

METAL STOPCOCKS

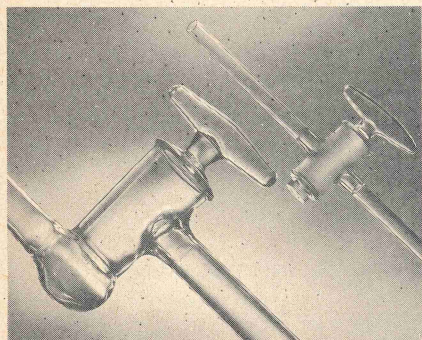


METAL STOPCOCK & NIPPLES

Designed especially for laboratory use with air pump plates and air pump accessories. These fittings may be used separately or in a wide variety of combinations. Instead of iron pipe threading, these fittings are threaded to fit Cenco Pump Plates and accessories, (7/16 inch dia., 16 threads per inch). All the stopcocks have been ground for use in vacuum work and are carefully inspected to assure vacuum-tight operation. Made of brass, polished and lacquered. By combining Nos. 94500 and 94505 Stopcocks with Nos. 94510 and 94515 Nipples, practically any desired combination can be made.

NO.	DESCRIPTION	BORE, IN.	EACH
94500	stopcock, double male screw	1/8	\$ 7.75
94505	stopcock, one male, one female	1/8	10.00
94510	nipple, female screw	3/16	1.30
94515	nipple, male screw	3/16	1.30

GLASS STOPCOCKS



HIGH VACUUM, TWO-WAY WITH OFFSET ARMS, PYREX GLASS 7546

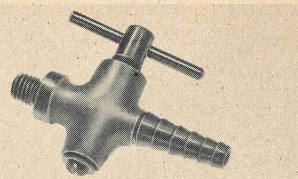
Provided with a glass cup beneath the barrel for use where highest vacuums are to be attained. This vacuum cup, on the vacuum side of the stopcock, assures firm seating of the plug by atmospheric pressure. Side arms, 20 mm O.D. Bore, 15 mm. Quantity in original case is 2.

No. 94342 \$27.80

MERCURY SEAL, TWO-WAY OBLIQUE BORE PYREX GLASS 7500

Provided with a cup at the top which acts as a seal and a bulb at the bottom of the solid core for evacuation and the elimination of leakage. The vacuum seal at the bottom prevents loosening of the core, which is carefully ground for high vacuum work. Arms are plain tubing. Quantity in original case is 6.

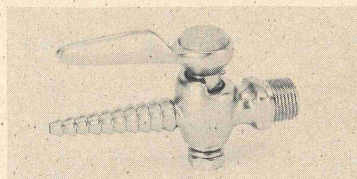
CENCO NO.	BORE OF CORE	APPROXIMATE O.D. OF ARMS	EACH
94325-2	2 mm	8 mm	\$ 9.20
94325-4	4 mm	10 mm	12.25



STOPCOCK

This vacuum system fitting has an extra long barrel with a 4 mm hole. It has a 7/16-16 male thread and a tapered serrated hose connection. The threaded end fits Cenco Pump Plates and accessories and the smallest serration is 10 mm in diameter. No. 15522 Lubricant is recommended for use with this unit.

No. 94520 \$26.25



LEVER HANDLE STOPCOCKS

For use on desk lines connected to a central compressed air system. Heavy cast brass, chromium-plated, with carefully ground valve seat and provided with extra long, serrated nipple for rubber tubing from 3/16 to 3/8 inch bore. A plastic index button is supplied for the lever handle with a choice of "AIR" or "VAC" engraved designation. Both models have 3/8" male I.P. thread.

No. 18901, with AIR button \$4.20
No. 18966, with VAC button 4.20

HIGH VACUUM, TWO-WAY WITH RIGHT ANGLE SIDE ARM, PYREX GLASS 7548

Similar to No. 94342 Stopcock, but with side arm projecting from the bottom of the vacuum cup for use where a right angle is desired. Arms, 20 mm O.D., Bore, 15 mm. Quantity in original case is 2.

No. 94344 \$27.80

MERCURY SEAL, THREE-WAY DOUBLE OBLIQUE BORE, PYREX GLASS 7540

Similar to No. 94325, but with three arms, two of which are sealed on one side of the barrel. Quantity in original case is 4.

CENCO NO.	BORE OF CORE	APPROXIMATE O.D. OF ARMS	EACH
94330-2	2 mm	8 mm	\$12.25
94330-4	4 mm	10 mm	15.20

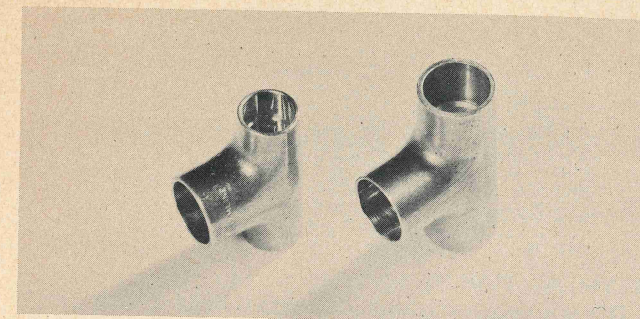
HIGH VACUUM, TWO-WAY OBLIQUE BORE PYREX GLASS 7544

Specially ground hollow plug stoppers and a closed cup at the bottom of the barrel make these stopcocks ideal for high vacuum work. The shells and stoppers are of greater length than in standard stopcocks to permit greater contact of ground surfaces. The special grinding plus larger surface area provide maximum protection from leakage.

The cup is evacuated through one of the side arms, causing the core to be held tightly in the barrel by atmospheric pressure. After evacuation, the stopcock is used without bringing the cup into communication with the main vacuum line. The possibility of leakage from the bottom of the stopcock is eliminated. Quantity in original case is 4.

CENCO NO.	BORE OF CORE	APPROXIMATE O.D. OF ARMS	EACH
94311-2	2 mm	8 mm	\$ 8.10
94311-4	4 mm	10 mm	9.85
94311-6	6 mm	12 mm	12.00

"T" AND ELBOW FITTINGS



VACUUM "T" FITTINGS

Made of wrought copper, these solder type "T" fittings are for installation in high vacuum or pressure lines. Will not impede gas or liquid flow. Straight through connections fit over tubing of the nominal (plumbing) sizes indicated. The "T" arm is 1/2" and takes a No. 94244 Brass Bushing threaded for 1/8" vacuum gage connections. Capillary action of solder filling the contact area creates a vacuum-tight seal. Meets ASA B16.22 and ASTM B-75 specifications.

CENCO NO.	NOMINAL SIZE, INCHES	PRICE
94243-1	1/4	\$1.10
94243-2	3/8	1.10
94243-3	1/2	.45
94243-4	5/8	1.65
94243-5	3/4	.85
94243-6	1	1.60
94243-7	1 1/2	3.90

VACUUM GAGE BUSHING

Fits into "T" arm of all No. 94243 Fittings to accept 1/8" FPT used on most vacuum gage heads. Flush machined brass.

No. 94244 \$0.85

VACUUM ELBOW FITTINGS

Made of wrought copper to meet ASA B16.22 and ASTM B-75 specifications. These solder type elbows fit over the ends of copper tubing and piping indicated in nominal (plumbing) dimensions. Actual O.D. of tubing is 1/8" larger than nominal size indicated.

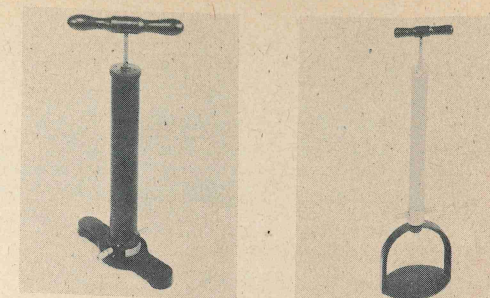
CENCO NO.	BEND	NOMINAL SIZE, INCHES	PRICE
94241-1	90°	1/4	\$0.50
94241-2	90°	3/8	.50
94241-3	90°	1/2	.25
94241-4	90°	5/8	.85
94241-5	90°	3/4	.60
94241-6	90°	1	1.20
94241-7	90°	1 1/2	2.25
94242-1	45°	1/4	.65
94242-2	45°	3/8	.70
94242-3	45°	1/2	.35
94242-4	45°	5/8	.95
94242-5	45°	3/4	.60
94242-6	45°	1	1.50
94242-7	45°	1 1/2	3.00

CENCO VACU RULE

A coated, paper slide rule for calculating pump speeds, tubing conductance, pressure at various altitudes and for calculating the pump required for various applications.

No. 94008 \$1.00

HAND-OPERATED PUMPS



VACUUM AND PRESSURE AIR PUMPS — 2 MODELS AVAILABLE

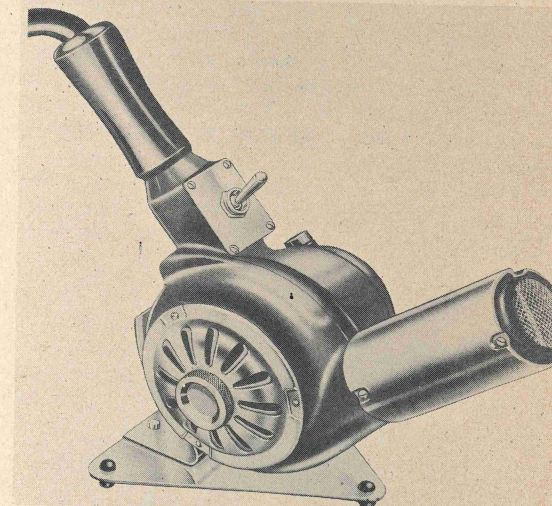
For use in elementary work in the laboratory and for other purposes not requiring a vacuum better than 20 mm. Cylinder is of brass, finished in blue-gray baked enamel, 36 cm long by 57 mm wide. Mounted on an iron base.

No. 93980 \$40.50

For use in elementary laboratory work and other purposes not requiring vacuums better than 50 mm. The brass cylinder is 26 cm long by 2.5 cm in diameter, nickel plated. Mounted on an easy-to-use stirrup, finished in blue-gray baked enamel.

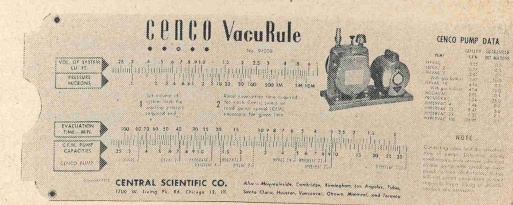
No. 93985 \$15.50

HEATER-BLOWER



These portable devices produce a constant stream of air at temperatures from 300° to 1000°F depending on the model. A useful tool for any vacuum laboratory to aid in outgassing through heating, when making glass-to-glass connections, warming gages, etc. Provided with an adjustable air intake for controlling the blast air temperature, a double jacketed housing, and a 10-ft. neoprene covered cord with plug. The universal motor operates on 115 volts, 50/60 cycles ac or on dc.

CENCO NO.	MAXIMUM TEMPERATURE	EACH
12945-1	300°F	\$37.25
12945-2	500°F	37.25
12945-3	750°F	41.25
12945-4	1000°F	52.00



SEALERS AND WAXES



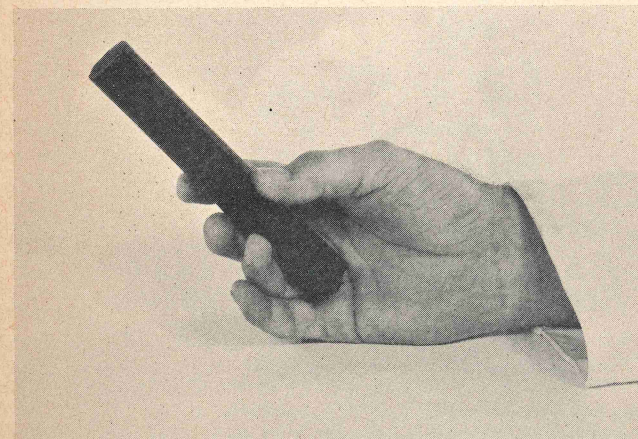
CENCO-SEALSTIX CEMENT

This is a superior, all-purpose adhesive cement or sealing compound for use in laboratory instrument and apparatus work. All parts cemented with it will be rigidly held whether used in air, vacuum, water or solutions of ordinary reagents. It is an improved cement of the deKhotinsky type in which all of the desirable qualities of the original have been retained or increased while the undesirable qualities have been eliminated or minimized.

Tests show that its adhesion to glass in a properly cemented joint is greater than the cohesive strength of the glass itself. Repeated heating and cooling will not embrittle or permanently harden the compound through polymerization so that it ceases to flow when reheated to the proper temperature. It does not become plastic in summer temperatures. Since Cenco-Sealstix has an exceedingly low vapor pressure, it is extremely valuable around high vacuum systems. It is odorless and is insoluble in practically all common reagents, except ethyl/alcohol, strong caustics, chromic acid cleaning solutions, acetone, dioxan, ethyl acetate and tertiary alcohols. These latter substances may be applied hot to remove the cement in inaccessible places. Stock should be stored in a cool place and renewed every six months, as polymerization may take place from time to time. Sold in sticks weighing approximately 1 ounce each, packed in individual cartons with directions for use.

No. 11430, per stick

\$0.90



CENCO "PLICENE" CEMENT

A plastic cement which softens with heating and melts at about 80°C. May be heated repeatedly without polymerization. Adheres firmly to practically all surfaces. May be used for sealing leaks in vacuum systems as the vapor pressure is low. "Plicene" is insoluble in water, is only slightly soluble in ethyl alcohol, but is easily dissolved by other liquid hydrocarbons. Dilute acids do not attack it, even after hours of exposure. It will withstand short immersion in dichromate cleaning solution with slight effect.

"Plicene" is easily applied from the stick by heating the parts to be joined slightly above 80°C and rubbing them with the cement, which melts and adheres firmly. If desired, the cement may be melted in an evaporating dish for application with a small brush. Supplied in sticks of about 75 grams each.

No. 11441

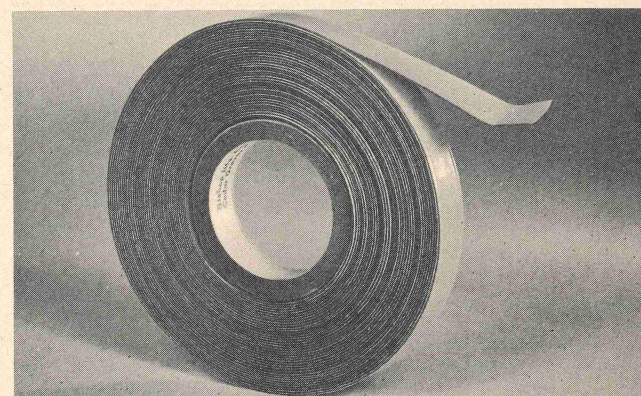
\$0.85



GLYPTAL PAINT

This is a viscous condensation resin suitable for finishing laboratory apparatus and equipment. Resists action of water, acids, and alkalis. Especially suitable for coating metal vacuum chambers, metal and glass connections, and rubber tubing in high vacuum systems to prevent leakage of air. Can be brushed or sprayed after being reduced with thinner to approximately 5 to 1. Dries to a hard, glossy film in approximately 8 hours at 70°F. Acetone is a solvent for removing the paint. Glyptal thinner (xylol or xylene) is recommended for reducing the body of the paint. In friction top cans.

CENCO. NO.	SIZE	EACH
10021-1	½ pint	\$1.20
10021-2	1 pint	2.15
10021-3	1 quart	4.00



SELF-BONDING VACUUM SEALING TAPE

Impervious connections of metal-to-metal, metal-to-glass, or glass-to-glass high vacuum system joints are made possible by use of this tape. Made of a combination of hydro-carbons, including polyethylene, it will resist the action of most acids and alkalis. It will not, however, resist petroleum products or aromatic compounds. No volatile plasticizers or surface adhesives are used in this tape.

It is recommended for use where the outside diameters of the connecting tubes are about equal. It may be employed with glass, metal, rubber (natural or synthetic), polyethylene or vinyl tubing. Its balanced mechanical strength and elasticity permit wrapping seals around the most complex contours. It is unaffected by temperature changes, moisture, ozone or long storage. If the joint is intended to be relatively permanent, a coating of shellac or glyptal may be applied. This tape also provides excellent insulation for electric wiring. Supplied in a 30 ft. roll with a cloth strip separator. Width of tape, ½ inch; thickness, 0.2 inch.

No. 94222

\$1.35

LUBRISEAL STOPCOCK GREASE

A lubricating, sealing and rust-proofing grease, nearly acid and alkali-proof. Can be used as a lubricant for glass or metal stopcocks and for sealing desiccators, anaerobic jars and similar articles. Melting point, approximately 40°C. In collapsible tube containing 25 grams.

No. 15523

\$0.50



CENTRAL SCIENTIFIC COMPANY



CENCO-VACUSEAL LIGHT BODY STOPCOCK LUBRICANT

Lubricates glass stopcocks, ground joints, etc., in high vacuum systems where the lubricated parts will not be subjected to temperatures above normal room temperature. The vapor pressure at normal temperatures is extremely low. The ASTM softening point, at which it begins to liquefy, is 50°C; ASTM penetration with 150 gram grease cone is 120 (0.1 mm) units at 25°C.

No. 15521-1, 1 ounce jar

\$0.60

No. 15521-2, 1 pound can

5.80

CENCO-VACUSEAL HEAVY BODY STOPCOCK LUBRICANT

Similar to the No. 15521 Lubricant, but with a heavier body and a higher melting point, for lubrication of ground joints in high vacuum systems where lubricated parts may be subjected to temperatures higher than normal room temperatures. The ASTM softening point, at which it begins to liquefy, is 60°C; ASTM penetration with 150 gram grease cone is 110 (0.1 mm) units at 25°C.

No. 15522-1, 1 ounce jar

\$0.60

No. 15522-2, 1 pound can

5.80



DOW CORNING HIGH VACUUM STOPCOCK LUBRICANT

Designed especially for high vacuum service. It has great stability, low vapor pressure and is unusually chemically resistant. Has the ability to "wet" and seal all types of surfaces. Because of its exceptional film strength, it maintains adequate thickness to assure easy stopcock operation. Consistency remains uniform over a wide range of temperatures. This lubricant does not become stiff when cold nor fluid when hot. Packed in screw-capped, glass jars.

No. 15517-1, 2 ounces

\$1.25

No. 15517-2, 8 ounces

4.50

DOW CORNING STOPCOCK LUBRICANT

This translucent, silicone lubricant is made for effective lubrication of stopcocks and ground glass joints. It is resistant to various chemicals, non-volatile and does not harden or melt at temperatures ranging from -40°C to +200°C. Packed in collapsible metal tubes.

No. 15515-1, 2 ounces

\$1.25

No. 15515-2, 8 ounces

4.50

CENTRAL SCIENTIFIC COMPANY

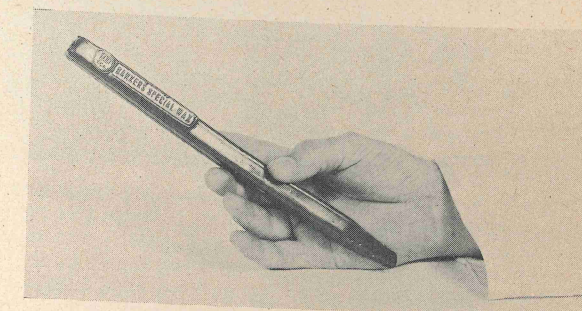


CENCO VACUUM SEALING WAX

Used for sealing joints in vacuum systems and attaching bell jars to pump plates. It is especially useful for sealing bell jars of metal evaporating and metal sputtering apparatus. This wax has a stiffer consistency and higher melting point than the No. 11455 Wax, and its vapor pressure at room temperature is even lower than that of the No. 11455. It liquefies at about 65°C. Packed in 8 ounce cartons.

No. 11456

\$2.25



RED EXPRESS SEALING WAX

For sealing stoppered glassware and glass system joints such as low temperature vacuum distillation systems. Very hard and brittle at room temperatures, this wax melts at about 75°C. In sticks of about 4 ounces.

No. 11445

\$0.25

CENCO VACUUM LUBRICANT WAX

A very soft wax for lubricating rubber tubing used in connecting glass tubing of vacuum systems. This wax seals minute air passages between the rubber and glass tubes and facilitates application of the rubber to the glass tube. Its vapor pressure at room temperature is considerably lower than the vapor pressure of mercury. It liquefies at about 50°C. Does not harden with age. Packed in friction top, 1 lb. cans.

No. 11455

\$1.80



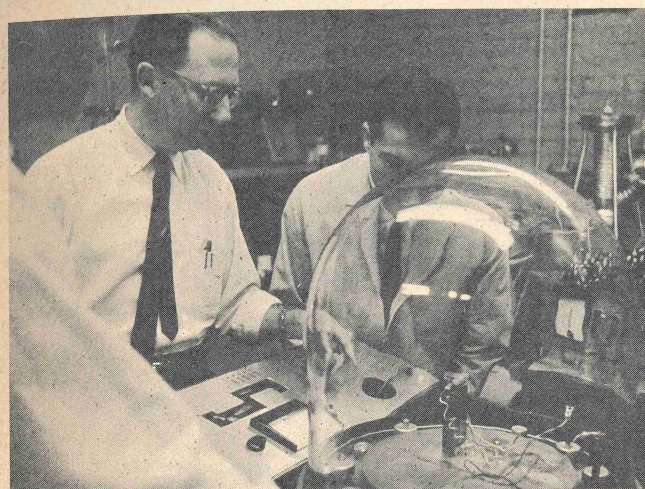
METAL STOPCOCK LUBRICANT

To provide metal stopcocks, especially those used under severe conditions of high heat, etc., with an insoluble and lasting lubrication. Consists of paste of colloidal graphite in grease body, which in use fills metal pores with graphite to produce low friction contact surfaces. 2 oz. cans.

No. 18970

\$1.50

PLANNING THE VACUUM SYSTEM



When planning the installation of a vacuum system, a fundamental question must be answered: "What is the proper pumping equipment for the job?" This is particularly true if the process or the application is new. The problem is not simply the selection of a pump. Many other factors have to be considered to secure the greatest efficiency of operation. In this resume some of these factors are considered, and general procedures are outlined which may be used in specific applications.

The order in which the material is presented is not necessarily the order of importance for a specific vacuum process. For example, if the pressures desired are above 10 millitorrs, the question of connections is relatively unimportant. On the other hand, if gases are to be handled at pressures of less than 10 millitorrs, the connections are of primary consideration. If the nature of the problem requires deviation from the use of ideal connections, a small pump may do just as good a job as one of larger capacity.

The topics discussed are: Pumping Speed; Connections and Speed of Evacuation; Merit Factor and Speed of the Pump; Low Pressure Technique; Gas-Ballast Pumps; How to Select a Pump.

PUMPING SPEED

Perhaps Gaede should be given credit for originating the concept of pumping speed. His equation

$$\frac{dp}{dt} = -S_1/V \times p \quad (1)$$

is the differential equation which defines pumping speed where p is the instantaneous pressure at the time t in a closed volume V being exhausted by a pump having a speed of S_1 . By implication S_1 is the volume of gas which the pump can remove from the enclosure in one second measured at the pressure p . The solution of this equation is

$$T = 2.3 \frac{V}{S_1} \log \frac{p_1}{p} \quad (2)$$

where T is the time required to reduce the pressure in the volume V from p_1 to p using a pump speed of S_1 .

To apply this relationship to a specific problem, reference is again made to the speed-pressure curves where the pumping speeds of Cenco pumps are shown at atmospheric pressure and at various pressures below 100 millitorrs. In the case of the Cenco Hypervac 25, the pumping speed at atmospheric pressure (the volume of free air displacement) is 4.4 liters per second;

at 100 millitorrs, 2.9 liters per second. Since within this pressure range the speed falls from 4.4 to 2.9 liters per second, the average speed of 3.7 liters per second should be used in determining the time required to reach a pressure of 100 millitorrs in a given application. A more conservative estimate is obtained if the lower figure of 2.9 liters per second is used.

To compute the time required to evacuate an enclosure to 1 millitorr, where the speed of the pump is 2.0 liters per second, the lower rather than the average speed should be used. Such calculations give a minimum pumping time since the effects of leaks or the evolution of adsorbed gases in the vacuum system were assumed to be negligible in writing Eq. (1) and (2). Under these circumstances, the actual pumping time will exceed the computed value.

As a further illustration, consider the time required for a Cenco-Hyvac pump to reduce the pressure within a directly connected 5-liter volume from atmospheric to a pressure of 100 millitorrs. Reference to the speed-pressure curve will show that the speed of this pump at atmospheric pressure is 0.17 liters per second; at 100 millitorrs, 0.10 liters per second. Upon substitution in Eq. (2)

$$T = \frac{2.3 \times 5}{0.14} \times 4 = 3.3 \times 10^2 \text{ sec.} = 5.5 \text{ min.} \quad (3)$$

The time, as determined by experiment, is 6.2 minutes. The time difference, 0.7 minute, suggests that adsorbed gases were liberated in the process.

CONNECTIONS AND SPEED OF EVACUATION

In the previous discussion it was assumed that the pump was directly connected to the vacuum chamber. This is the ideal but rarely attained situation. Usually a connection of some length is required between the pump and the vacuum chamber. Under such circumstances the pump speed S_1 is not the controlling factor. In making "pump-down" calculations, particularly if pressures below 10 millitorrs are involved, the speed of evacuation S rather than the pump speed S_1 determines the period of cyclic operations.

When the pump is operating in the low millitorr range, the flow of gas through a tube is substantially molecular in character. In other words, at low pressures the gas removed from the system is largely confined to those molecules which, because of their kinetic energy of agitation, happen to hit the intake of the pump when the cylinder of the pump is open to the intake. The flow of gas Q at low pressures is linearly related to the pressure and this fact leads to simple mathematical relationships analogous to those of direct current theory. Specifically,

$$Q = PS, \quad (4)$$

$$C = \frac{Q}{P_1 - P} \quad (5)$$

The value of C is a function of the dimensions of the tube connecting the pump with the exhaust chamber. This quantity C (the conductance of the connections) is a measure of their proper selection.

Conductance of various sized tubes may be determined from the curves in which $L + 8/3R$ is plotted against C , the conductance in cc's per second. L and R are the length and inside radius of the connecting tubes. It can be shown that the speed of evacuation S is related to the speed of the pump S_1 and the conductance C by the following relationship:

$$\frac{1}{S} = \frac{1}{C} + \frac{1}{S_1} \quad (6)$$

On rearranging the terms

$$S = S_1 \left(\frac{C}{C + S_1} \right) \quad (7)$$

The significance of this expression is very important. The fractional term in the expression is less than 1. Consequently, the speed of evacuation S can never be greater than the conductance C nor can it be greater than the speed of the pump S_1 . The expression suggests that the speed of evacuation approaches the speed of the pump only when C is very much larger than S_1 .

This points up the fact that a high-speed pump may be made ineffective by the use of improper connections.

In case several lengths of different diameter tubing are connected in series between the pump and exhaust chamber, the conductance C for the combination is given by

$$\frac{1}{C} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n} \quad (8)$$

where b_1, b_2 , etc. are the respective conductances of the tubes.

In calculating the time of exhaustion of a system from atmospheric to a lower pressure, S computed from Eq. 6 should replace S_1 in Eq. 2. As an illustration, consider the time of evacuation of a 10-liter system to 1 millitorr in which the connections consist of a 50-cm. tube having an inside diameter of 2 cm. The conductance of a tube of these dimensions is 1.8 liter per second.

To obtain a conservative value for the "pump-down" time, the pump speed S_1 at 1 millitorr taken from Figure 1 is to be used. These values are shown in column 2 of Table 1. Upon substitution of these various values of S_1 and C in Eq. 7 various speeds of evacuation are obtained, as shown in column 3. The approximate time for these pumps to evacuate this system under the conditions indicated is computed from Eq. 3 using the various values of S shown in the table.

TABLE 1

V = 10 liters		Z = 1.8 1/sec.	
PUMP	S_1 (1/SEC.) AT 1 MILLITORR	S (1/SEC.) AT 1 MILLITORR	T (MIN.)
Hyvac	.079	.075	31.0
Megavac	.37	.30	7.7
Hypervac 25	2.0	.95	2.4
Hypervac 100	11.0	1.5	1.5
Hyvac 2	.14	.13	17.3
Hyvac 7	.52	.41	5.7
Hyvac 14	1.05	.66	3.5
Hyvac 28	4.65	1.3	1.76
Hyvac 45	7.5	1.45	1.58

Column 2 of Table 1 indicates that the connection selected is quite satisfactory if a Hyvac 2 pump is used. On the other hand, the value of S with a Hypervac 100 is about 14% of the pump speed. If the Hypervac 100 is used, it would be desirable to make the connection 8 cm. in diameter in which case C is approximately 90 liters per second, S would be 9.9 liters per second, and T is 14 seconds. In this particular illustration, if time is not a factor and if very little gas is to be handled in the millitorr range, a Hyvac or a Megavac pump is suitable for the job. If time is a big factor or if large quantities of gas are to be handled in the millitorr range, the larger connection and the Hyvac 28, Hyvac 45, or Hypervac 100 are needed.

Where the problem is of such a character that very long or very small diameter tubing must be used or where constrictions at some point between the pump and the vacuum chamber must be tolerated, the use of a high-speed pump is an expensive luxury. The "conductance effect" becomes of lesser importance at pressures higher than 10-100 millitorrs so that in many instances high-speed mechanical pumps can be justified for use in the high millitorr range even though small connections are of necessity required.

MERIT FACTOR AND SPEED OF THE PUMP

In many vacuum processes, the speed of evacuation at a particular pressure is of extreme importance. For example, after attaining a pressure of one millitorr, a large flow of gas may be liberated so that the pressure remains relatively constant over long periods of time.

It has been previously shown that the speed of the pump in combination with the conductance of the connections establishes the speed of evacuation at these low pressures. This factor can be improved by the proper selection of the connecting tubes, but in addition a great deal can be done by selecting a pump which has an appropriately large pumping speed at these pressures.

An arbitrary but significant measure of a mechanical pump with reference to its pumping efficiency at low pressures is known as the merit factor. This quantity is defined as the ratio of the pumping speed at 1 millitorr to that at atmospheric pressure. The nearer this quantity approaches 1 (or 100% if a percentage scale is used), the greater is the efficiency of the pump at low pressures. A smaller pump may require a longer time to reach the millitorr range, but it may have a higher speed in this range.

LOW PRESSURE TECHNIQUE

Vacuum processes vary as to minimum pressure requirements. In case considerable quantities of gas must be handled at pressures below 0.5 millitorr, diffusion pumps are required. This is particularly true where cyclic operations are involved and the time to reach a very low pressure range is economically important. Commercially available diffusion pumps have a variety of pumping speeds and operate satisfactorily with backing pressures of from 10-100 millitorrs. Such pumps are usually backed with mechanical pumps.

Fluids used in diffusion pumps often deteriorate if their temperatures are elevated when in contact with air at pressures of 100 millitorrs and above. Unless appropriate steps are taken, this means that a certain amount of time is lost in heating and cooling the boiler in a cyclic operation. To avoid this loss of time, various techniques are used. In some instances, two parallel pumping systems are installed. One consists of a high-speed mechanical pump directly connected to the vacuum chamber and a second independent connection in which a relatively small mechanical pump backs a diffusion pump. During the preliminary pumping period or when air is admitted to the vacuum chamber the intake to the diffusion pump is closed but the pumps are permitted to operate. In operation the high-speed mechanical pump withdraws the air from the chamber to the millitorr range after which the diffusion pump is placed in operation so that the reduction in pressure continues without interruption. In another arrangement only one mechanical pump is used. More shut-off valves are required because the mechanical pump is first connected to the vacuum chamber and later placed in series with the diffusion pump.

As an illustration, reference is made to the production of certain rare metals in a vacuum furnace. In one such instance, a Hypervac 100 pump is directly connected to the furnace. Paralleling this is a high-speed diffusion pump backed with a Hyvac 28. One valve is used between the diffusion pump and the furnace. The Hypervac 100 quickly reduces the pressure in the furnace to the millitorr range after which the parallel pump combination is cut in and the system is ready to handle the large quantities of low pressure gas given off by the heated metal. It is to be noted that the Hypervac 100 operates during the entire pumping cycle. Although its pumping speed at 0.1 millitorr and lower is negligible as compared to the speed of the diffusion pump. Its construction is such as to prevent air from entering the furnace at pressures below its normal limiting pressure. This eliminates the necessity for a second valve and makes possible a very high conductance for the Hypervac 100 connection to the furnace. In other applications, such as the electron microscope, a single mechanical pump is used, and it is switched, by valving, from direct connection to the vacuum chamber to the position where it acts to back the diffusion pump.

A number of factors should be considered in selecting a backing pump. The choice will be largely influenced by the arrangement of the equipment, the volume of the vacuum chamber, the quantity of gas to be handled at low pressures and the importance of time in cyclic operations. One consideration that is generally common to various arrangements is the speed of the backing pump. This is directly related to the speed of the diffusion pump and the ratio of pressures at the discharge and intake of the diffusion pump. On the assumption that a particular diffusion pump has a speed of 100 liters per second at 10^{-3} millitorrs and that the pump operates satisfactorily at a backing pressure of 10 millitorrs, the ratio of pressures is 1 to 10,000.

This means that a backing pump capable of handling .0001 of 100 liters per second or .01 liter per second is theoretically sufficient for the job. This suggests that a relatively low speed backing pump is sufficient in this case. However, there are usually other factors that must be considered. If parallel pumps are used, as previously described, the selection of a backing pump on this basis will generally yield the desired results. However, if the boiler of the diffusion pump is cooled down during the cyclic operations or if large quantities of relatively high pressure air must be drawn through the diffusion pump or through a parallel connection, a larger backing pump than that indicated by such calculations will be necessary. Usually a backing pump with a safety factor of 10 or more should be selected.

GAS-BALLAST PUMPS

The principle of gas-ballast in vacuum pumps is comparatively simple. A vacuum pump utilizing this feature is able to pass water vapors or other condensable vapors through the pump and exhaust them with practically no internal condensation. The gas-ballast pump is ideally suited for pumping vapors which do not chemically attack or dissolve into the pump oil. If the pump oil should be contaminated, it may be purified by temporarily shutting off the system from the pump and allowing the pump to run idle for a suitable length of time. This procedure eliminates the need for oil separators, refrigerated traps, centrifuges and other means that are frequently used. Numerous changes of oil may be eliminated with the use of a gas-ballast vacuum pump. Gas-ballast pumps are especially suitable for industry in the fields of vacuum distillation, vacuum drying, vacuum casting of metals, vacuum ovens, and other similar applications where condensable vapors may be present.

HOW TO SELECT A PUMP

Processes which require high vacuum are increasing in number. In various applications, vacuum systems must handle gases and vapors ranging from pure air to vapors which are highly corrosive. The latter cause considerable difficulty and very special equipment is required. Where clean air only is involved, the problem is much simpler. Water vapor which is present in many vacuum processes presents certain problems. Usually these can be solved so as to prevent damage to the vacuum pumps or interference with the process. No one pumping system will meet all requirements. Every new application presents new problems. Usually it is best to select the pumping and gaging equipment to meet the requirements of each application.

To evacuate a system against atmospheric pressure, mechanical pumps are generally used. Cenco has been a pioneer in the manufacture of mechanical pumps producing a series having free air displacements up to 16 liters per second.

A major factor in maintaining good pumping speeds at low pressures is the vapor pressure of the oil used in the mechanical pump. Cenco-Hyvac Oil is processed to yield a very low vapor pressure. It is the proper oil to use in all Cenco mechanical pumps.

At the ultimate pressure the pumping speeds of a mechanical pump is zero. For two-stage pumps the ultimate pressure is approximately .05 to 0.1 millitorr; for single-stage pumps, 0.5 to 1 millitorr. Since many vacuum processes require lower pressures, diffusion pumps are required. Diffusion pumps will maintain constant pumping speeds from their ultimate pressures to roughly a millitorr. At their ultimate pressures (apparently zero measured speed) diffusion pumps are actually in equilibrium with their outgassing systems. The backing pressure required for a diffusion pump will depend upon the throughput it is expected to handle and is generally a fraction ($\frac{1}{10}$ to $\frac{1}{4}$) of the limiting fore-pressure against which it will work. A mechanical pump should be selected to maintain this fraction of the limiting fore-pressure (rated) on the exhaust side of the diffusion pump.

For those processes requiring the use of both a diffusion and a mechanical pump, the mechanical pump must produce at least as great a number of millitorr-liters per second, (throughput), as the diffusion pump.

In general, the throughput of the mechanical pump in millitorr-liters per second should be higher than that of the diffusion pump; in some processes, much higher. This is particularly true if the mechanical pump is required to reduce the pressure of the system to the operating pressure of the diffusion pump in a short length of time. A chart showing the throughput at various pressures for our diffusion pumps and mechanical pumps is shown on each page a pump is listed. These are referred to as speed-pressure curves. From the speed-pressure curves, a proper selection of pump combinations can be made. First one determines the ultimate pressure required and estimates the in-leakage and outgassing rates. With this information the selection of pumps can be made from the curves.

Suppose a pressure of 0.01 millitorr is desired in the system and at this pressure the total flow of gas expected from leakage and outgassing is 1 millitorr-liter per second. To sustain a pressure of 0.01 millitorr at this throughput of 1 millitorr-liter per second, a diffusion pump with a speed of

$$S = \frac{Q}{P} = \frac{1 \text{ millitorr-liter/sec.}}{.01 \text{ millitorr}} \quad (9)$$

$$= 100 \text{ l./sec.}$$

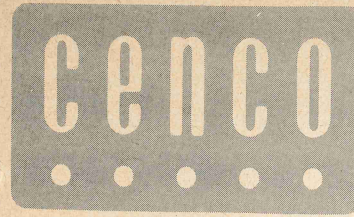
is required.

This speed at this pressure is less than that offered by the No. 93245 MC 275 Diffusion Pump and therefore this would be the diffusion pump of minimum capacity capable of meeting the requirements of the system. The limiting fore-pressure for this diffusion pump is 90 millitorrs as stated in the catalog. Therefore the mechanical pump used for backing this diffusion pump must be able to handle a throughput of 1 millitorr-liter at no higher than 90 millitorrs. However, operating the diffusion pump at this high fore-pressure, while possible, does not make any allowance for surges in throughput or outbursts of gas. Thus it is wise to assume an operating fore-pressure of no more than a fraction of this value, say, 15 millitorrs. This means that a mechanical pump with a speed of

$$\begin{aligned} S &= \frac{Q}{P} = \frac{1 \text{ millitorrs-liter/sec.}}{15 \text{ millitorrs}} \\ &= .066 \text{ 1/sec.} \\ &= 4 \text{ 1/min.} \end{aligned} \quad (10)$$

is required. Again, by reference to the proper speed-pressure curve, and recalling that the fore-pump speed will be decreased by whatever conductance exists between it and the diffusion pump, it is seen that the Hyvac 14 has a greater speed and would be adequate to back the No. 93245 diffusion pump under the given circumstances. As previously mentioned, it is desirable to select a pump of greater speed than this analysis indicates if the "pump-down" time for the cycle is critical.

For some high capacity diffusion pumps it is impossible to achieve the required backing characteristics with mechanical pumps. In such a case, "booster pumps" may be used between the diffusion and the fore-pump. Booster pumps are not capable of maintaining extremely low pressures, but they exhaust against higher backing pressures than diffusion pumps. They take a quantity of gas at a lower pressure from the diffusion pump, compress and deliver it to the mechanical pump at a higher pressure. A dual purpose is served: first, to bridge the throughput gap between the output of the diffusion pump and the capacity of the mechanical pump; second, to provide fore-pressure within the operating range of the large high-speed diffusion pump which in this instance cannot be maintained by the mechanical pump.



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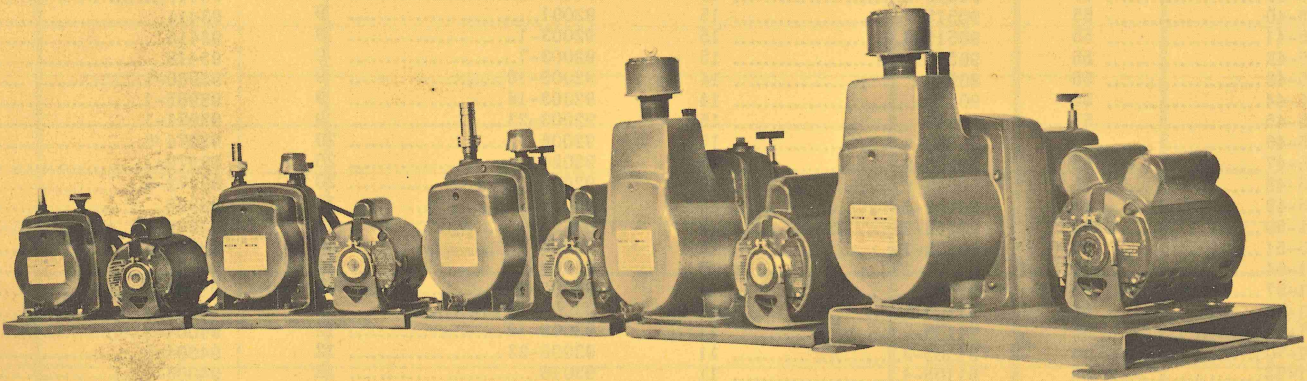
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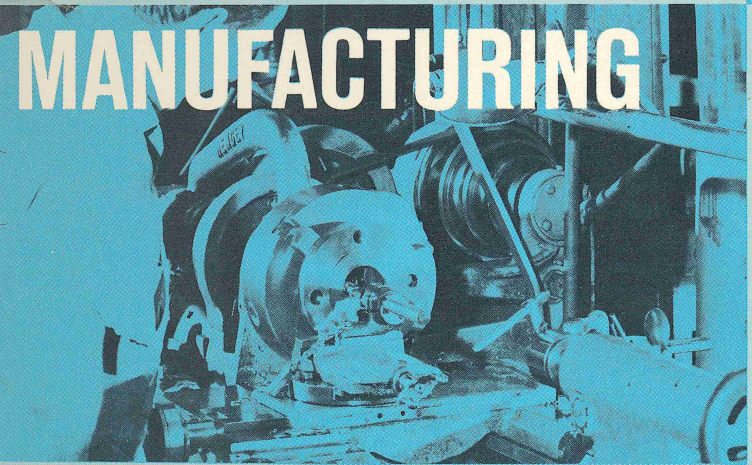


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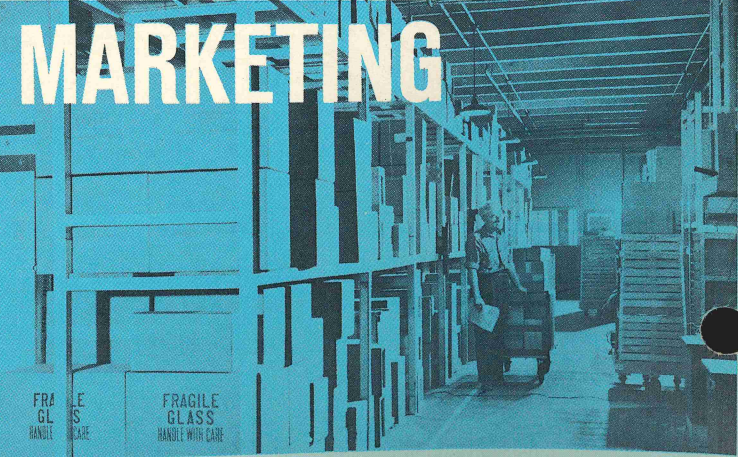
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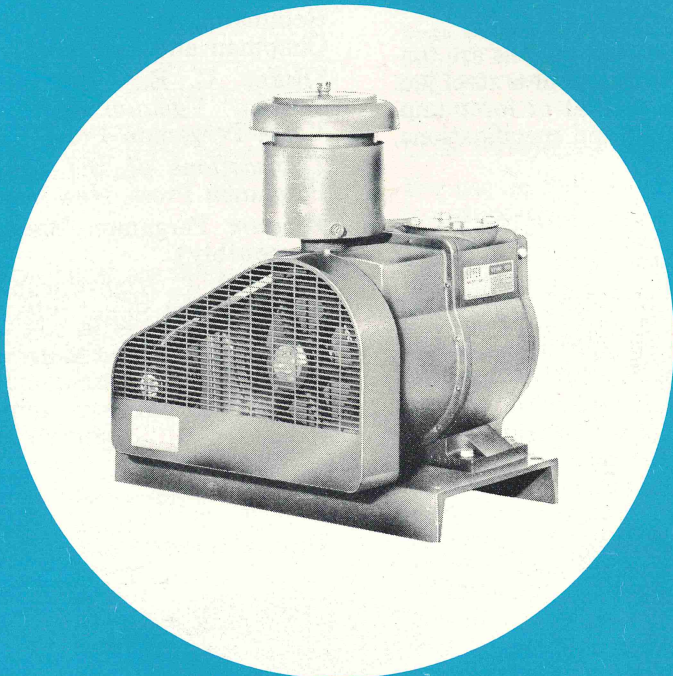
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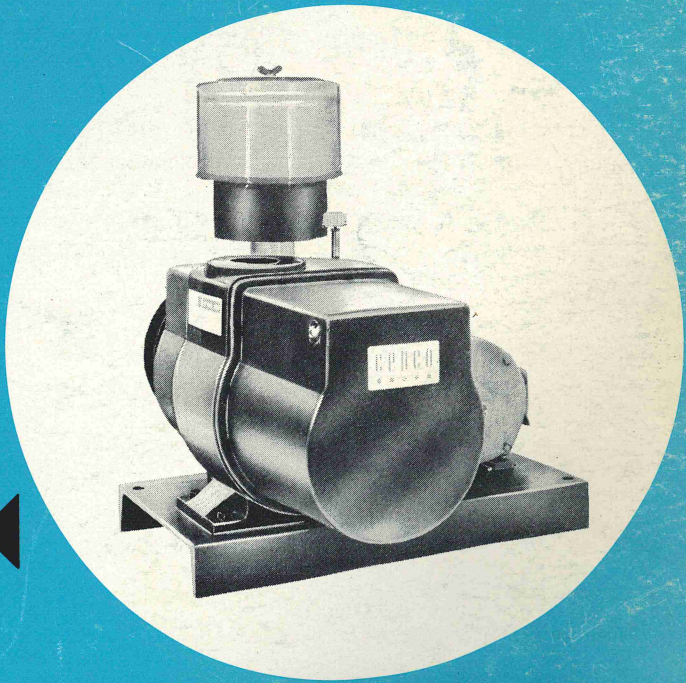
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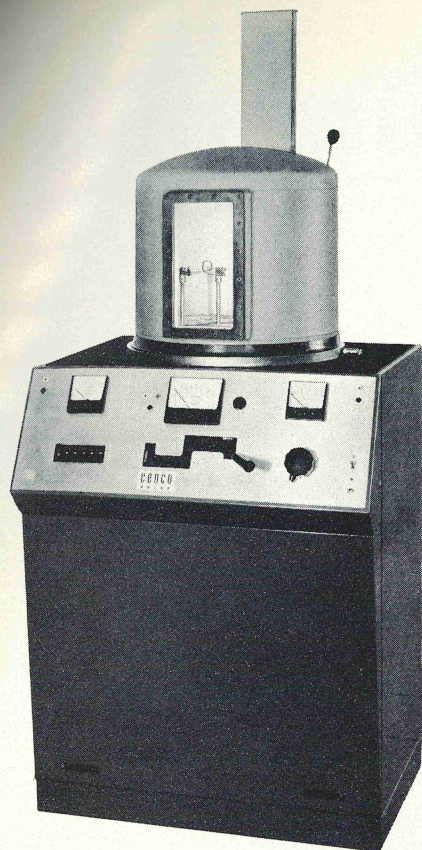


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	VACUUM	at atmosphere	at 1 millitorr			
	(millitorr of mercury)	(liters per min.)	(liters per min.)			
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	Hyvac 7	10.0	79		—	
	Hyvac 14	5.0	140		—	
	Hyvac 28	5.0	280		—	
	Hyvac 45	5.0	450		—	
	Pressovac	15.0	35	—	325	
	Blower Pump	3 IN. Hg.	35	—	326	
DOUBLE STAGE PUMPS	Hyvac	0.3	10	5	320	
	Hyvac 2	0.1	25	13	321	
	Hyvac 4	0.05	48	25		
	Hyvac 6	0.1	65	30		
	Hyvac 7	0.1	79	35		
	Hyvac 14	0.1	140	75		
	Hyvac 28	0.05	280	150		
	Hyvac 45	0.05	450	280		
	Hyvac 150	0.05	1500	1275	319	
	Hyvac 225	0.05	2250	1800		
	Hyvac 300	0.05	3000	2250		
		Megavac	0.1	57	22	323
		Hypervac 23	5.0	240	—	324
	Hypervac 25	0.1	264	120		
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NO. 94700 LABORATORY VACUUM SYSTEM

A light weight, compact unit designed to be used in research laboratories, industrial production and pilot plants, where a completely self-contained unit is required for a wide variety of vacuum applications. This unit is ideal for high vacuum deposition of metals on optical and other surfaces.

A 19-inch diameter pump plate is connected through the Cenco Three-Way Valve to a high speed diffusion pump backed by a Hyvac 14 mechanical pump. The Three-Way Valve replaces the roughing, foreline and high vacuum valves now used in conventional systems. The quick mechanical movement of its single lever operation eliminates the lack of reliability and high cost associated with pneumatic and solenoid operated valves. It also prevents costly errors due to operating valves in the wrong sequence. A built in water-cooled baffle minimizes backstreaming from the diffusion pump.

The bell jar can be evacuated within five minutes to a working vacuum of 1 micron of mercury as read on the vacuum discharge gage connected to the pump plate. A few more minutes of pumping will attain 0.1 micron—excellent for evaporation. The system is also equipped with a thermocouple gage which gives the foreline pressure to the operator, thereby indicating when to switch in the diffusion pump.

The implosion proof, aluminum alloy bell jar offers full visibility of the chamber interior through a large plastic window. The bell jar is raised by a self-contained spring-loaded hoist to quickly expose the pump plate and its nine electrodes. Twelve volts ac at 100 amperes are available at two pairs of electrodes. Four other electrodes are connected to external jacks on the front panel. They extend the versatility of the system by permitting electrical measurements of phenomena to be made from outside the bell jar or power to be introduced to operate rotating sectors or other devices in the vacuum chamber. The remaining electrode will maintain a glow discharge by a self-contained 5000 v power supply to clean objects before coating.

All prices F.O.B. our nearest branch as of publication date. Applicable taxes will be added. Exact current prices available on request. Terms: 30 days net.

We have attempted to describe accurately the merchandise listed in this bulletin. Additional information will be gladly given upon request. The company warrants that each item of merchandise sold by it is free from defective workmanship or material upon return of the same to the company office at Chicago, Illinois. This warranty is made in lieu of all other warranties, express or implied, and no other warranty, express or implied, is assumed or will be assumed.

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1 introduction

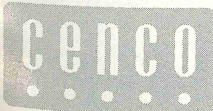
1.1 General: The Cenco Hyvac 150, 225, and 300 Pumps are two-stage, high-capacity mechanical vacuum pumps based on Gaede's internal-vane principle. Combining quiet, vibrationless operation, and high pumping speed with low ultimate pressure, the Cenco 150, 225, and 300 Hyvac Pumps are best suited for heavy-duty vacuum work, such as evacuating space chambers, pumping down large vacuum furnaces, and backing ultra-vacuum diffusion pumps in environmental testing and space condition simulation. These pumps may also be used as roughing pumps in general-purpose high vacuum applications and as forepumps in conjunction with diffusion pumps, such as Cenco Nos. 93415 and 93416. Specifically, the Cenco Hyvac Pumps can be used in the following high-vacuum commercial applications:

- **Vacuum Metallurgy** — Thermal Reduction, Distillation of Metals, Vacuum Sintering, Heat Treatment, Vacuum Melting
- **Vacuum Dehydration** — Blood Plasma, Biologicals, Foods
- **Vacuum Evaporation** — Low-Reflection Coatings on optical surfaces and reflecting surfaces, Decorative Coatings, Electrically Conductive Coatings
- **Vacuum Sputtering** — Coating of Non-Conductors
- **Vacuum Distillation** — Distillation-Point Reduction, Molecular Distillation
- **Vacuum Impregnation** — Condensers, Coils, Transformers, Cables, and other electrical insulating materials

- **Miscellaneous** — Manufacture of Refrigerators, Bellows-type Barometers, Vapor-operated Thermometers; Television Receivers, Vacuum Bottles, etc.; Evacuation of High-voltage X-ray Tubes, Large Magnetrons, Cathode-Ray Tubes.

1.2 Plus Features of Hyvac 150, 225, and 300 Pumps

- A special valving arrangement for easy start-up even when the stages are filled with oil—a condition which results when the pump is stopped and allowed to remain under vacuum.
- A rotor specially designed to increase the capacity of the pump.
- High-conductance, internal connections between intake and exhaust stages for optimum performance.
- A separate chamber, incorporated within the rotors, for outgassing the pump oil. Sufficient conductance between rotors permits degassing by the exhaust stage at a very high rate.
- A centrifugal oiling system to force oil from inside the hollow rotors through the clearances between rotor and end plate as the rotors spin. This oil flow lubricates the moving parts and serves also as sealant between stages.
- Sufficient volume in the rotor chamber to allow retention of the oil that usually seeps into the pump when the latter is stopped while still under vacuum. This feature minimizes the possibility of oil backing into the vacuum system.



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2 principle of operation

2.1 Single Stage Pump: Since the Hyvac 150, 225, and 300 Pumps incorporate two, distinct, single stages mounted back to back, to understand how a two-stage pump works, it is only necessary to understand the operating principle of a single-stage pump.

A typical, internal-vane, vacuum pump consists of a motor-driven cylindrical rotor eccentrically mounted within a larger housing, or stator. Two spring-loaded vanes are mounted in the rotor, parallel to its axis, in diametrically opposed slots. The vanes bear against the wall of the stator under spring pressure and centrifugal action. The eccentric mounting of the rotor provides a permanent point of contact between stator and rotor and divides the stator in two sections, or stages: intake and exhaust. A thin film of oil at the point of contact maintains effective vacuum sealing, thus preventing the passage of gas between stages. Two openings in the stator serve as gas intake and exhaust ports. The intake port is connected to the system to be evacuated.

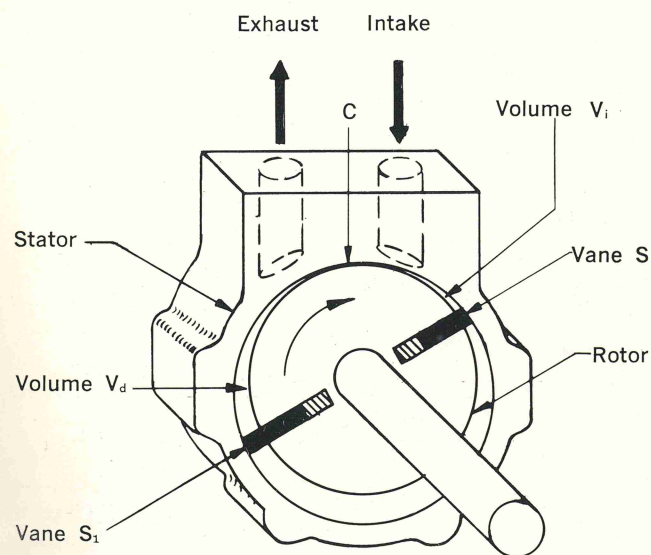


Fig. 1—Operating principle of an internal-vane vacuum pump

Figure 1 illustrates the internal vane principle, on which Gaede built his "Kapselpumpe" in 1910. As the pump is driven by a motor, the rotor turns, and the spring-loaded vanes slide in and out of their slots, maintaining positive contact with the wall of the stator throughout every revolution. As a result, gas in the space between the two vanes is pushed forward, compressed to atmospheric pressure, and expelled through the exhaust while additional gas is sucked in through the intake. As the rotor turns, the volume behind vane S increases from the instant vane S slides past the

sealing area, or contact point C. This increasing volume V_i allows more gas from the system being evacuated to enter the intake stage. At the same time, the volume V_d ahead of vane S_1 decreases, thereby forcing gas to be compressed and expelled from the exhaust stage. The compressed gas is kept from entering the intake stage by the oil seal at the contact point C. A single stage pump of this type produces a vacuum of about 5 millitorr.

2.2 Two-Stage Pump: A typical vacuum pump of this type consists of two pumping stages, a high-vacuum stage and a roughing stage, connected in series. The stages are mounted side by side and are separated by a common wall—ground plane parallel—through which a hole has been drilled. The hole serves as both the exhaust port of the high-vacuum stage and the intake port of the roughing stage. While volume V_d in the former is decreasing, air is being expelled in volume V_i of the roughing stage. The air in the volume V_d of the high-vacuum stage is not compressed appreciably; as a result, leakage into the high-vacuum stage is minimized. A two-stage pump of this type produces a vacuum of 1 millitorr or better.

3 specifications

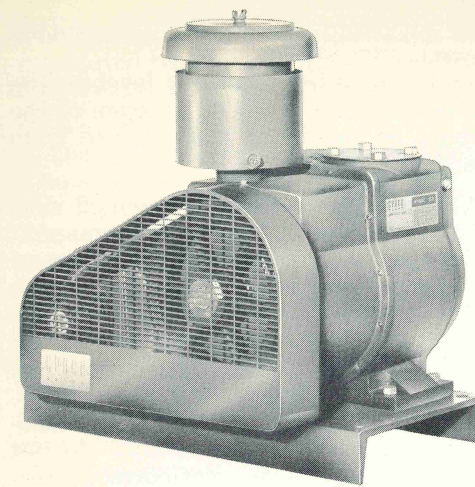
3.1 Pump Data: The speed-pressure characteristics of the Cenco Hyvac 150, 225, and 300 Pumps are illustrated in Fig. 2. The following table lists additional pump data and specifications:

Pump Model Cenco No.	Hyac 150 91957	Hyac 225 91959	Hyac 300 91960
Capacity			
at atmospheric pressure,			
liters/minute	1500	2250	3000
cubic feet/minute	53	79	106
at 1 millitorr,			
liters/minute	1275	1800	2250
cubic feet/minute	46	63	79
Guaranteed Vacuum, millitorr	0.05	0.05	0.05
*Merit Factor, %	85	81	75
Pump Speed, rpm	465	465	465
Oil Required, quarts	20	24	28
Overall Dimensions, inches			
Length	31	31	31
Width	22 1/2	27	30 1/2
Height	29 1/2	29 1/2	29 1/2
Intake Flange Data			
Opening, OD, inches	3 1/8	3 1/8	3 1/8
Bolt Circle, OD, inches	5 1/2	5 1/2	5 1/2
Bolt Holes, NC thread	5/8-11	5/8-11	5/8-11

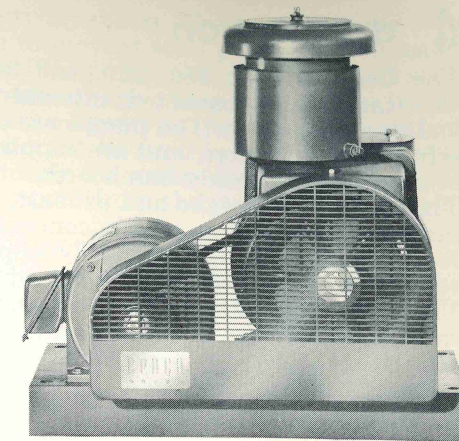
*Merit factor is the ratio of the pumping speed at 1 millitorr to the pumping speed at atmospheric pressure.

3.2 Motor data

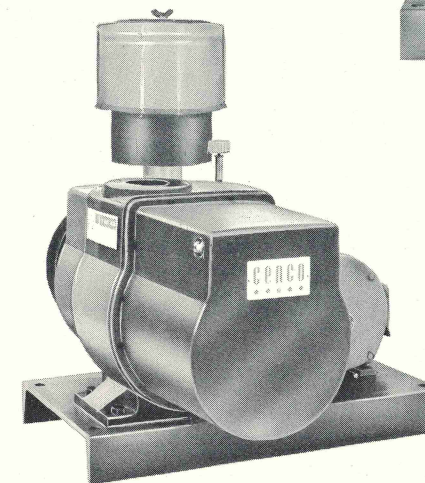
	Hyac 150, 225 and 300
Motor Horsepower	3
Motor Type, phase	3
Voltage, volts	220/440
Frequency, cps	50/60
Power Demand, watts	
at 50 cycles	2770
at 60 cycles	2330



HYVAC 150



HYVAC 225



HYVAC 300

Cenco Double-Stage, High-Vacuum Pumps: Hyvac 150, 225, and 300

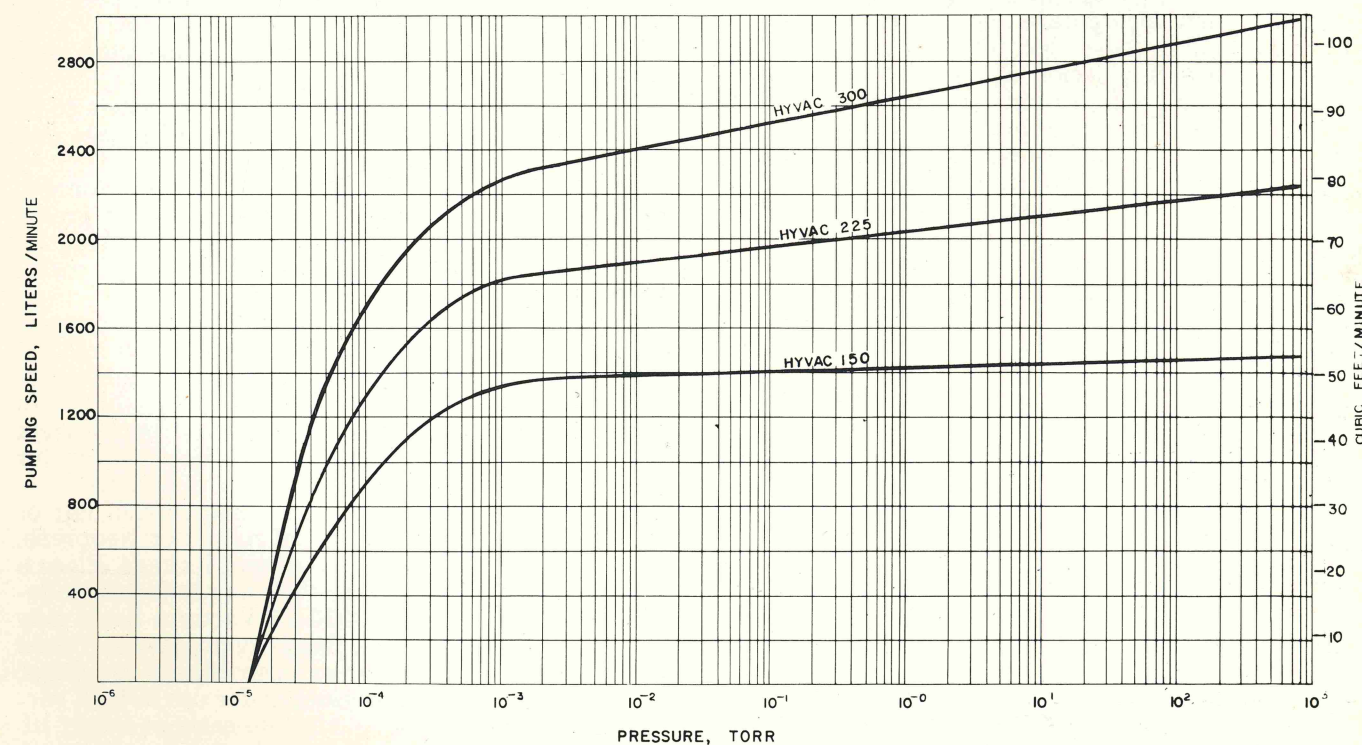


Fig. 2—Pumping speed and pressure characteristics of the Hyvac 150, 225, and 300 pumps

4 description

The Cenco Hyvac 150, 225, and 300 Pumps are two-stage, series-connected, internal-vane, mechanical vacuum pumps. The pumps are driven by powerful, electric motors, and are supplied unmounted or mounted on sturdy baseboards.

The two stages, intake and exhaust, consist of cylindrical chambers in which concentrically driven rotors are mounted eccentrically to provide a high-vacuum seal between the rotors and the chambers. The intake and exhaust ports of each stage are located on both sides of the sealing area. Two spring-loaded, sliding vanes are mounted in the slots of each rotor.

For easy startup, the Hyvac 150, 225, and 300 Pumps are provided with fly-away, flat steel valves which open when the pressure in the pump exceeds 15 psi, and allow excess oil to be discharged to atmosphere without first being circulated through the exhaust stage. Another important component of the valving system is a double-purpose exhaust valve used to discharge excess oil from the exhaust stage. One part of the valve is a spring-loaded, heavy steel plate which covers a 2-inch square hole. This plate opens when large quantities of gas and oil are being exhausted. The other part of the valve is a thin, spring-steel plate which covers four 5/8-inch holes. This plate opens to exhaust the usual small quantities of gas encountered at low operational pressures. The Pump mechanism is completely immersed in oil. The oil bath insures a vacuum-tight seal of the stages; cools the pump interior; and lubricates the moving parts through the oiling holes. The lubricating oil is degassed by the exhaust stage before it is allowed to reach the intake stage. Eventually, the oil becomes contaminated with volatiles and water droplets, and it must be replaced.

To prevent contamination of the pump oil when condensable vapors are pumped, a gas ballast feature has been incorporated in the Hyvac pumps. The gas ballast valve, located at the rear of the housing, allows regulation of the air flow (gas ballast) during the compression cycle of the stage. This ballast flow reduces the compression ratio of the vapor in the stage, thus preventing condensation of the vapor and emulsification with the oil. Mounted on the pump is an exhaust-filter dome that effectively traps oil in the exhaust.

The oil bath is contained within two housings on which are mounted the drain cock, the oil level sight gage, and the oil shaft seal.

The Hyvac Pumps 150, 225, and 300 are shipped mounted on a heavy metal base together with a high-quality, 3-hp motor. A belt drive connects the motor to the pump. Supplied with each pump is a set of three matched, molded-rubber V belts, an all-metal belt guard that completely encloses the belt drive, and enough oil for one filling.

5 installation

5.1 Pump Mounting: Each mounted pump is shipped ready for immediate installation. The major dimensions of the pump, pump base and motor are given in Fig. 3. Provisions should be made for bolting the base to the floor or, if the pump is to be used in a movable unit, to the frame. When electronic equipment is attached to the same frame, shock mounts should be installed so that vibrations

from the motor or pump will not be transmitted through the frame.

A pump should be mounted perfectly level so the oil level can be read accurately. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump.

5.2 Motor Connections: Motors supplied with the Hyvac 150, 225, and 300 require permanent connections. Connect the motor to a power line of the voltage, frequency and phase indicated on the nameplate of the motor. The power line should be heavy enough to carry the current required without causing any undue drop in voltage. All motors can be operated on across-the-line start.

Remember that fuses provide short-circuit protection only for the power supply line; they do not protect the motor from overload. For correct selection of the power-line fuse, consult Table I. A suitable starting switch with motor overload protection should be used for all permanent installations.

Table I
ELECTRICAL DATA

Current Demand, amps	
at 220 volts, 50 cps	12.6
at 220 volts, 60 cps	10.6
at 440 volts, 50 cps	6.3
at 440 volts, 60 cps	5.3
Maximum Line Fuse Rating, amps	
at 220 volts	60
at 440 volts	30

5.3 Vacuum Connections: The Hyvac 150, 225, and 300 pumps are provided with 2 1/2 inch ASA standard flange connections. It is recommended that the following procedure be observed when making any vacuum connections:

- (1) Remove the plastic protective cover from the intake flange of the pump.
- (2) Remove the plug from the exhaust port, and install the exhaust dome.
- (3) When connecting the pump to the system to be evacuated, take extreme care to eliminate any source of leakage.
- (4) Make sure that both members of each connection are coated with vacuum stopcock grease and that all connections to metal tubing fit snugly. It is best to solder or braze all metal connections.
- (5) If threaded pipe joints are used, the threads should be as perfect as possible. When making threaded connections, screw the members together a few turns, and then apply Glyptal to the exposed threads before screwing them tightly together. Allow the Glyptal to dry for several hours before starting the pump.
- (6) If flanged connections are used, install flat or "O" ring gaskets, made of rubber or Neoprene, between the flanges to prevent leakage. Place a thin coat of oil on the "O" ring before installation. Cenco No. 90020-25 Vacuum Seals may be used for intake flange connections. Cenco also manufactures an extensive line of couplings, connections and accessories for use in high vacuum systems.
- (7) For maximum gas flow and minimum pressure drop, make all vacuum connections as short as possible, and use tubing of as large a diameter as possible.

The conductance of various sizes of tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008, or may be determined from Fig. 4, in which the quantity $(L + \frac{4}{3}D)$ is plotted against Z , the conductance in cubic centimeters per second. The symbols L and D represent the length and inside diameter of the tubes in centimeters. The average pumping speed of the system, then, may be found by solving the following relationship:

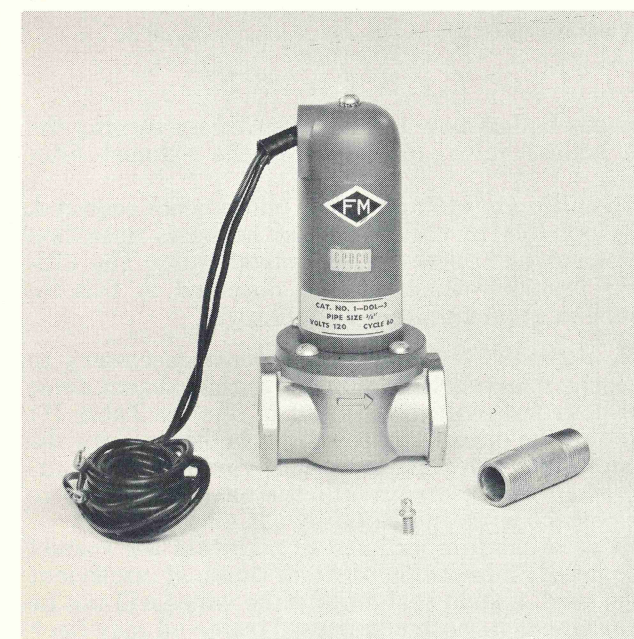
$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pumping speed, taken from Fig. 2, and Z is the conductance of all the tubing or the connecting line between the pump and the system. The time required to evacuate a vessel of volume V is given by the formula:

$$T = \frac{2.3V}{S} \cdot K$$

where T is the time in seconds, V the volume of the vacuum system expressed in liters, and S the average pumping speed expressed in liters per second, for operation from atmospheric to final pressure. The factor K has values of 4, 5, and 6. The value 4 is used for a final pressure of 100 millitorr, 5 for 10 millitorr, and 6 for 1 millitorr.

5.4 Valve Connections: Generally, metal vacuum valves and glass stopcocks are employed in the connecting line between the pump and the system for connecting the vacuum gage and for releasing the vacuum system after pumping has been terminated. When metal tubing is used, a high-vacuum valve, such as No. 94551 or 94280, is recommended.



Low-Pressure Solenoid Valve, Cenco No. 94280

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of leak-testing the pump and the system by the pressure-rise method without disconnecting the pump from the line.

5.5 Vacuum-System Traps: Extreme care must be taken to prevent solid particles from reaching the intake of the pump, otherwise they will score the working parts of the pump and reduce its efficiency. If corrosive vapors are present in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor (from the pump) from entering the system.

A Cenco No. 94009 Liquid Nitrogen Trap is recommended for this purpose. For detailed specifications on the traps, refer to Section 8, Accessories.



Liquid Nitrogen Traps, Cenco No. 94009

If large amounts of water vapor are pumped and a large ballast flow is used, some oil mist will be discharged with the ballast air and vapor. It is a good hygienic practice to pipe the exhaust outside the work area. For this purpose, remove the filter dome and connect a 3-inch IPS pipe directly to the exhaust outlet. For best performance, a simple condensing trap should be provided in the exhaust line as close to the pump as possible to prevent the condensate, which will form in the pipe, from running back into the pump.

5.6 Gages: The types of high vacuum gages commonly used in a system employing a Hyvac pump are the McLeod, Pirani, discharge, and thermocouple gages.

A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 mm Hg to 1.6 mm Hg (0.5 to 1600 millitorr). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint.

The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 millitorr and from 1 to 50 millitorr.

The Thermocouple gage permits pressure measurements in the range from 1 to 1000 millitorr.

The Discharge gage operates within the range of 0.001 to 20 millitorr.

All vacuum gages are illustrated and described in Section 8, Accessories.

5.7 Oil Requirements: Each Hyvac Pump is shipped with enough oil in the pump reservoir for operation. Before refilling, consult Section 6.3.

Table II
OIL REQUIREMENTS

Pump Model	Oil Supplied with pump, Gallons	Oil Required for one filling, Pints
Hyvac 150	5	40
Hyvac 225	6	48
Hyvac 300	7	56

6 operation

6.1 Starting up the Pump: When a rotary vacuum pump is turned off without being let up to atmosphere on its intake side, oil, driven by atmospheric pressure, begins to fill the volume between stator and rotor. Because the pump and its valves are designed to handle compressible gas, not incompressible oil, the electric motor often cannot turn the rotor over against the resistance of oil-filled passages.

This difficulty is never experienced with the Hyvac 150, 225, and 300 Pumps. The fly-away flat valves allow for direct discharge of excess oil to the atmosphere; the double-purpose valve permits exhaustion of oil through the exhaust stage. *If the pump has been properly installed, it will begin to pump immediately each time the motor is turned on.*

6.2 Gas Ballast: The gas ballast pump is ideally suited for pumping all vapors which do not chemically attack or dissolve in the pump oil; water is a typical example. Even after contamination of the oil has occurred, the gas ballast pump is able to purify the oil if the system is temporarily shut off from the pump and the pump kept running for a suitable length of time. The contaminated oil will continually circulate from the oil supply channel into the high vacuum side, where the contaminant will evolve as vapor. This vapor then will be discharged with the ballast air as described before, until eventually all the contaminant has been expelled. For this reason, the oil of a pump employing the gas ballast does not have to be changed as often as the oil of pumps which do not have the gas ballast. Although it is impossible to calibrate the gas ballast control for all pumps at all operating pressures, it is useful to know the effectiveness of different gas ballast flow rates on the pumping of vapors. The following formula will enable the user to calculate the maximum pumping rate of insoluble vapors without their contaminating the pump oil:

$$W = DV \cdot \frac{P_a}{P_e - P_s} \cdot \frac{T_p}{T_a} \text{ (g/min)}$$

where:

T_p = pump temperature ($^{\circ}\text{K}$) (taken as pump oil temperature)

T_a = ambient temperature ($^{\circ}\text{K}$)

P_a = barometric pressure (torr)

P_s = saturation pressure of pumped vapor at pump temperature T_p (torr)

P_e = pressure under pump exhaust valve at instant of exhausting (torr)

V = rate of dry gas ballast flow at atmospheric pressure P_a (lit/min)

D = density of pumped vapor at temperature T_p and pressure P_s (g/lit)

W = maximum safe mass rate for pumping vapors (g/min)

Solving for the special and frequently encountered situation of pumping water vapor, and treating this vapor as a perfect gas, so that at exit,

$$D_{\text{water vapor}} = \frac{18}{22.4} \cdot \frac{P_s}{760} \cdot \frac{273}{T_p}$$

$$= 0.289 \frac{P_s}{T_p} \text{ (g/l)}$$

and, assuming a pressure of 850 torr below the exhaust valve at the instant of exhaustion, and then substituting the density of water vapor, we obtain as the maximum safe pumping rate for water vapor:

$$W_{\text{water vapor}} = 0.289 \left(\frac{V}{T_a} \right) \left(\frac{P_a P_s}{850 - P_s} \right) \text{ (g/min)}$$

Using 10 lit/min gas ballast flow, we obtain the maximum water-vapor pumping rates shown in Table III when no condensation is in the pump:

Table III
WATER-VAPOR PUMPING RATES

Pump Temperature in $^{\circ}\text{C}$	Maximum Water-Vapor Pumping Rate in g/min	
	With zero humidity in gas ballast air	With 100% humidity in gas ballast air
50	0.91	0.72
60	1.60	1.39
70	2.84	2.59
80	5.38	5.08

For above data

$$P_a = 760 \text{ torr}$$

$$T_a = 20^{\circ}\text{C} = 293^{\circ}\text{K}$$

The gas ballast flow can be adjusted by turning the gas ballast valve, located near the exhaust filter dome.

If the ultimate vacuum of the pump is not required, it is possible to obtain almost noiseless operation by "cracking" open the gas ballast valve. The ultimate pressure which can be obtained in this instance is approximately 30 millitorr.

6.3 Adding Oil: When it becomes necessary to refill the reservoir with oil, remove the exhaust dome and pour the required amount of oil (see Table II) through the opening in the drain housing. Turn the pump pulley several revolutions by hand while pouring oil in the reservoir. Fill the oil reservoir up to the correct level, indicated by the oil level gage.

It is of utmost importance to maintain the correct amount of oil in the pump at all times. If insufficient oil is used, a good seal around the vanes will not be maintained; if too much is used, some oil may back up through the pump trap and into the vacuum system.

NOTE: Oil shooting from the exhaust dome of an operating pump indicates that the pump contains too much oil. If this happens, stop the pump and drain oil slowly until the oil level is at the proper height. It is good vacuum practice to take an occasional check of the oil level while the pump is running.

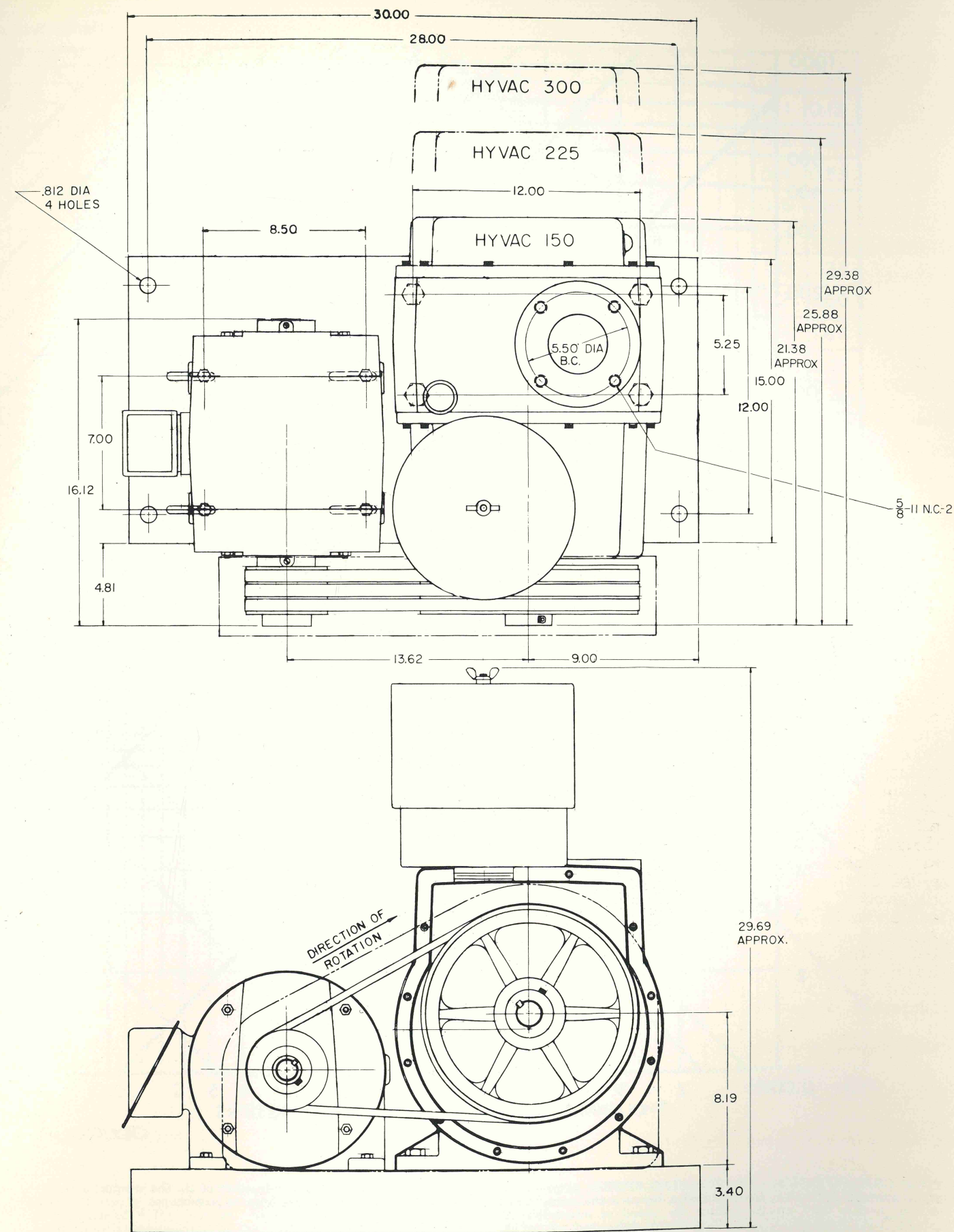
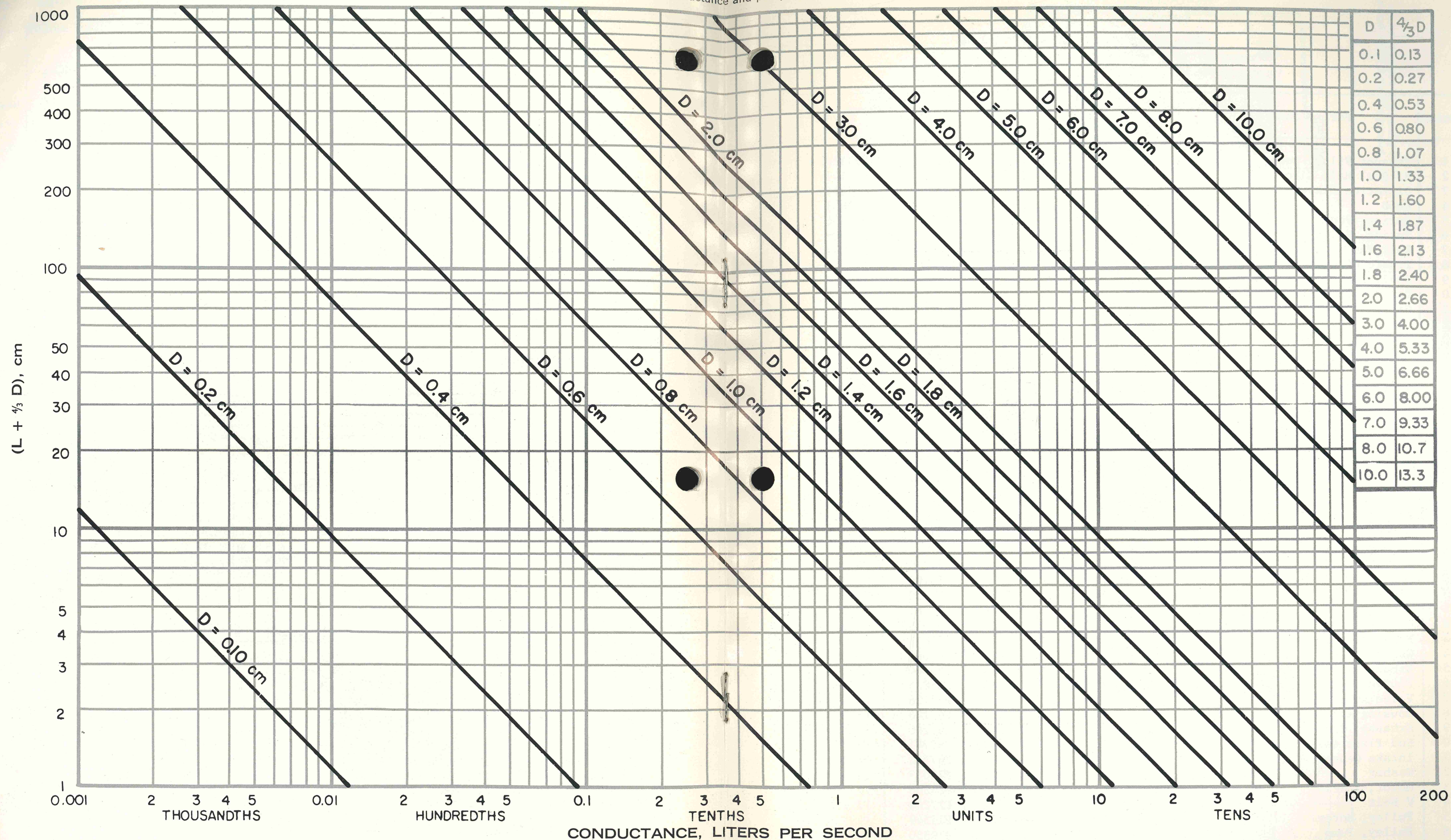


Fig. 3—Essential dimensions of the Hyvac 150, 225, and 300 pumps

Fig. 4—Tube conductance and pumping speed



TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently, the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain a pumping speed (S) as large as possible, the tube conductance (Z) must be very large when compared with the speed of the pump (S_1). This is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} S_1$$

Since at best S is only a fraction of S_1 , the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance (Z), shown in liters/sec., is plotted as abscissas against the quantity $(L + \frac{4}{3}D)$ in cm, as ordinates. In addition to the parameter D , the value of $\frac{4}{3}D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm long, having a diameter of 2 cm, is required. As it can be seen from the table, for $D = 2$, the value of $\frac{4}{3}D = 2.66$ cm. Referring to the curve, for $D = 2$ the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines spaced logarithmically, conductance of tubes having diameters other than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely $\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$ where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

Table IV
REPLACEMENT PARTS

Symbol	Part Name	Quantity Required			Part Number		
		Hyvac 150	Hyvac 225	Hyvac 300	Hyvac 150	Hyvac 225	Hyvac 300
1	Exhaust Filter Dome	1	1	1	093126-4	093126-4	093126-4
2	Hi-Seal Male Elbow	1	1	1	P16141	P16141	P16141
3	Direction Plate	1	1	1	P25363	P25365	P25366
4	Knob	1	1	1	P26081	P26081	P26081
5	Spring, Vane	4	6	6	P28105	P28105	P28105
6	Spring, Valve	4	4	4	P28106	P28106	P28106
7	Roll Pin	4	4	4	P29283	P29283	P29283
8	Truarc Ring	3	3	3	P29532	P29532	P29532
9	Seal, Shaft	1	1	1	P29538	P29538	P29538
10	Cap Screw, 1/2-13 x 6-1/2	6	12	6	P29545	P29545	P29545
11	Cap Screw, 1/2-13 x 10	-	-	6	---	---	P29547
12	Gasket	2	2	2	P35846	P35846	P35846
13	Shaft	1	1	1	P61238	P61239	P61240
14	Main Body	1	1	1	P61242	P61242	P61242
15	Intake Stator	-	1	1	---	P61243	P61244
16	Exhaust Stator	1	1	1	P61245	P61245	P61245
17	Rotor, 3-1/2 inches	1	2	1	P61247	P61247	P61247
18	Rotor, 7 inches	1	1	2	P61248	P61248	P61248
19	Vane, 3-1/2 inches	2	4	2	P61249	P61249	P61249
20	Vane, 7 inches	2	2	4	P61250	P61250	P61250
21	Exhaust End Cap	1	1	1	P61251	P61251	P61251
22	Intake End Cap	1	1	1	P61252	P61252	P61252
23	Valve, Flapper	2	2	2	P61253	P61253	P61253
24	Housing, Exhaust Valve	1	1	1	P61256	P61256	P61256
25	Exhaust Valve	1	1	1	P61257	P61257	P61257
26	Housing, Shaft Seal	1	1	1	P61261	P61261	P61261
27	Key, Shaft, 1/4 x 1/4 inch	4	6	6	P61262	P61262	P61262
28	Key, Shaft 5/16 x 5/16 inch	1	1	1	P61263	P61263	P61263
29	Stud, Valve	4	4	4	P63779	P63779	P63779
30	Pin, Vane	4	6	6	P63780	P63780	P63780
31	Tube	1	1	1	P63781	P63781	P63781
32	Disk	1	1	1	P65646	P65646	P65646
33	Bracket, Valve	2	2	2	P65862	P65862	P65862
34	Washer, Thrust	2	2	2	P65863	P65863	P65863
35	Exhaust Valve Stop	1	2	1	P65864	P65864	P65864
36	Flutter Valve	2	2	2	P65865	P65865	P65865
37	Valve Assembly	1	1	1	P67738	P67738	P67738
38	Housing Assembly	1	1	1	P67739	P67748	P67749
39	Exhaust, Center Plate Assembly	1	1	1	P67740	P67740	P67740
40	End Plate Assembly	2	2	2	P67741	P67741	P67741
41	Intake Center Plate Assembly	-	1	1	---	P67742	P67742
42	Washer	12	12	12	P78037	P78037	P78037
43	Motor, 3 HP	1	1	1	P24205	P24205	P24205
44	V Belt	3	3	3	P27204	P27204	P27204
45	Pulley, Motor	1	1	1	P29549	P29549	P29549
46	Pulley, Pump	1	1	1	P29550	P29550	P29550
47	Bushing	1	1	1	P29551	P29551	P29551
48	Bushing	1	1	1	P29552	P29552	P29552
49	Base, Pump	1	1	1	P61287	P61300	P61300
50	Belt Guard	1	1	1	P67750	P67750	P67750
51	Light Hyvac Oil, 5 Gallons	1	1	1	093050-4	093050-4	093050-4
52	Light Hyvac Oil, 1 Gallon	-	1	2	---	093050-3	093050-3
53	Unmounted Pump	1	1	1	P91957	P91959	P91960

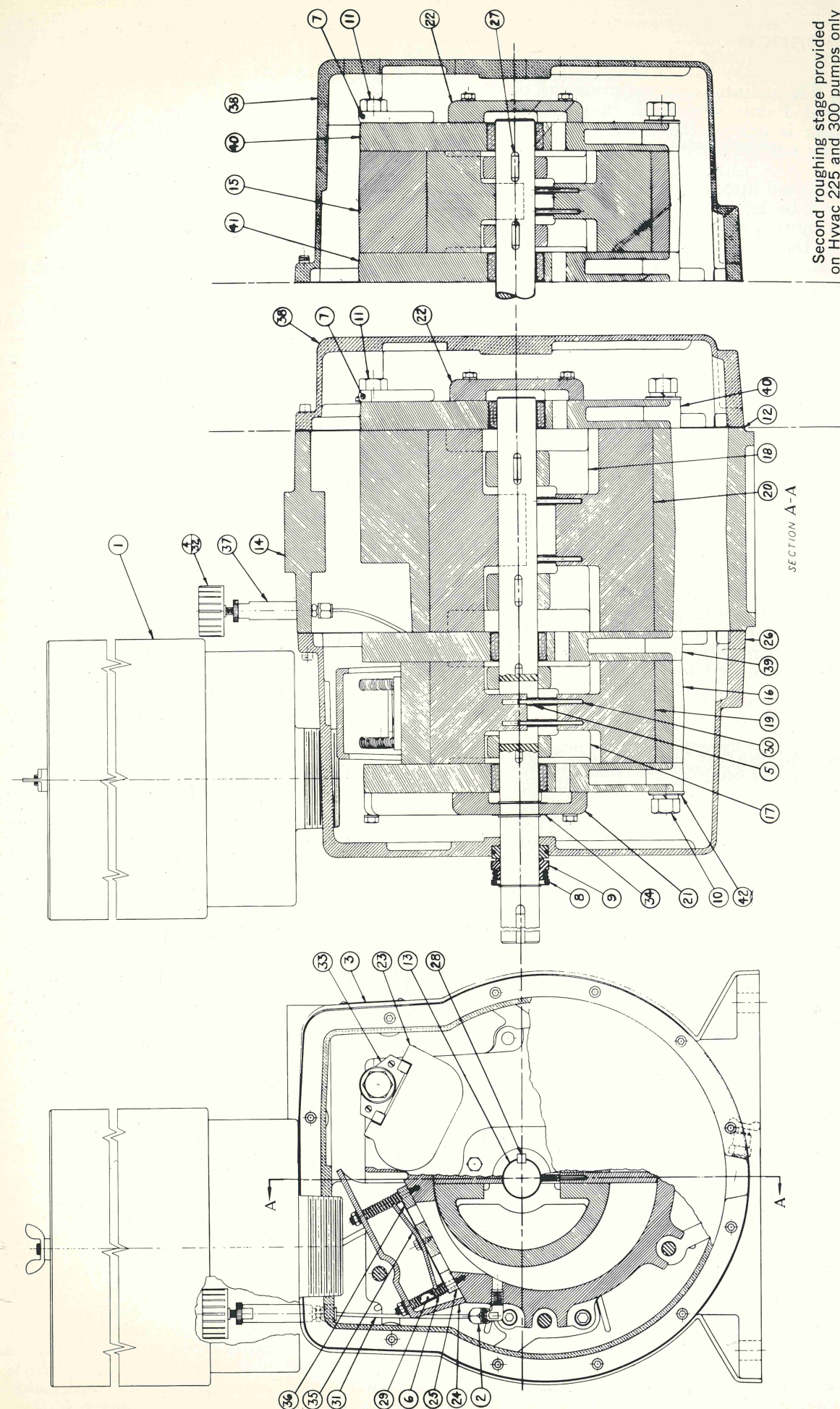


Fig. 5—Sectional view of the Hyvac 150, 225, and 300 pumps

7 maintenance

7.1 General: The maintenance requirements of the Cenco Hyvac Pump vary with application. Proper lubrication is one of the most important factors in securing reliable performance (See Paragraph 7.2).

If a pump is connected into a normal leak-free system, there should be no malfunction that might not be remedied by simple adjustments. If a pump fails to function, the cause usually can be attributed to a minor mechanical failure such as a broken spring, a sticking vane, or worn valve release, rather than to misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal operation, where no corrosive vapors are encountered, there will be no decrease in the efficiency of a pump over a period of several years.

7.2 Oil Change: A decrease in the value of maximum vacuum attainable is usually an indication that the oil has become contaminated. Oil should be changed at the first sign of contamination.

To remove the oil, stop the pump, place a large receptacle underneath the drain, and open the drain cock. Turn the shaft several revolutions to force out any remaining oil. Flush with clean Flushing Oil, No. 93060, at least once and then refill with new Hyvac Oil No. 93050.



Hovac Oil, Cenco Nos. 93050 and 93055, and Hyvac Flushing Oil, Cenco No. 93060

The frequency of oil change is dependent upon the use of the pump. An oil change may be needed only once in six months if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosive or highly condensable vapors enter the pump.

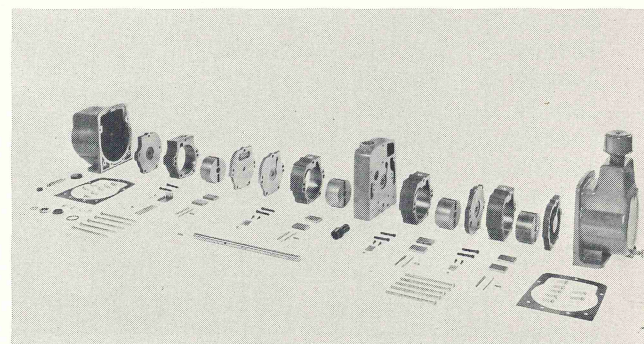
When the pump is operated continuously, the oil temperature may reach 50° to 60°C. This temperature is normal for efficient operation of the pump.

7.3 Belt Adjustment: The belt in mounted pumps can be adjusted by loosening the bolts in the base of the motor and moving the motor in the

required direction. The belt should be just tight enough to prevent slippage while operating. A little slippage on starting is desirable.

7.4 Shaft Seal Replacement: The seal on the pump shaft, symbol (13) in Fig. 5, consists of a "Truarc" ring (8), a thrust washer and the shaft seal, in that order. Before re-assembling or making a replacement, apply a thin film of pump oil to the pump shaft. Also apply the same amount of oil to the inner surface of the shaft seal. Replace the shaft seal carefully so as not to damage the inner surface of the rubber seal ring. Push the seal back into the cavity until it contacts the "O" ring. Replace the thrust washer, and force the washer and spring over the groove in the shaft. Finally, replace the "Truarc" ring.

7.5 Repairs: Fig. 5 shows cross sectional views of the Hyvac Pump. Table IV lists the part number for each component of the pump. When ordering replacement parts, please give the exact part number. For repairs to the pump other than the replacement of the shaft seal, it is strongly recommended that the pump be returned to the factory, especially when adequate shop facilities are not available. If operated according to instructions, any Hyvac pump will provide years of satisfactory service. If trouble develops, turn off the pump at once. Only a qualified technician who has available the finest machine shop facilities should attempt to service the pump, using the drawings and charts provided. If the difficulty cannot be corrected immediately, contact your nearest Cenco Branch office or the Service Department, giving all symptoms of the malfunction and wait for further instructions. *Do not return the pump or any of its components without written authorization from Cenco.*



Typical Hyvac Pump disassembled for servicing

Easy Servicing

The techniques used in the manufacture of Cenco pumps assure interchangeability of parts from pump to pump and eliminate the need for selective parts fitting. This permits users to service or repair pumps on the spot without the need of special tools and equipment or highly-trained personnel. Parts are stocked in Cenco's coast-to-coast warehouse system and are immediately available to users everywhere. In addition, Cenco offers regular factory repair service at its main plant.

8 accessories

Cenco McLeod Gage, Double Range

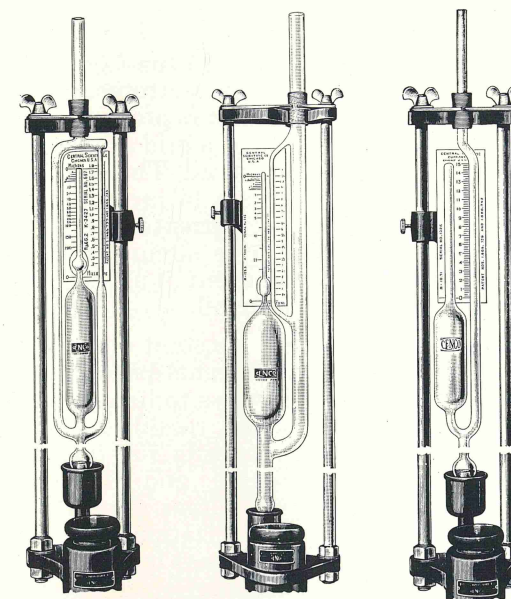
For all measurements of pressure from 0.5 millitorr to 1600 millitorr. One range reads in millitorr from 0.5 to about 200 or 250; the other to about 1.6 torr. Over-all height is 165 cm. The amount of mercury required is about 10 pounds. Weight, without mercury, 30 pounds.
No. 94151, without mercury

Cenco McLeod Gage, Improved Design Double Range

Similar to the No. 94151 but for pressures from about 0.005 to 1000 millitorr. Double range, with one scale reading to approximately 25 millitorr and the other to approximately 1000 millitorr. This gage is intended for use in a system being exhausted by means of a diffusion or a molecular pump. It is made with replaceable precision-bore tubing. This gage requires about 30 pounds of mercury for operation. Over-all height is about 190 cm; weight, without mercury, is about 45 lbs.
No. 94156, without mercury

Cenco McLeod Gage, Single Range

Similar to No. 94151 McLeod Gage, but with single range from 0 to 15 torr, reading to 0.1 torr. Scale magnification by the McLeod principle is about 10. For accurate measurement of gas pressures in the filling of discharge tubes and in measurements of pressure in industrial processes. About 10 lbs. of mercury are required.
No. 94160, without mercury



94151 94156 94160

Cenco measuring heads for the 94151, 94156, and 94160 McLeod Gages.

Cenco Mercury for McLeod Gages

CP, ACS, Triple distilled quicksilver.

1 pound, bottle

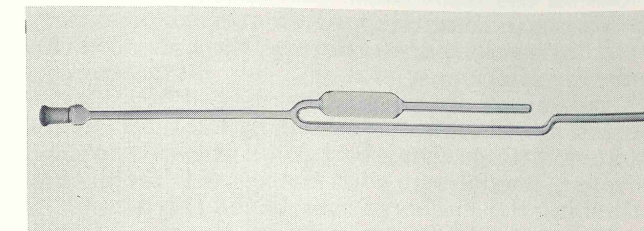
5 pound, bottle

15 pounds maximum quantity for parcel post shipment.

McLeod Gage Glassware

Extra glassware for Nos. 94151, 94156 and 94160 Cenco McLeod Gages. Consists of calibrated glass head with interchangeable ground joint and a calibrated scale.

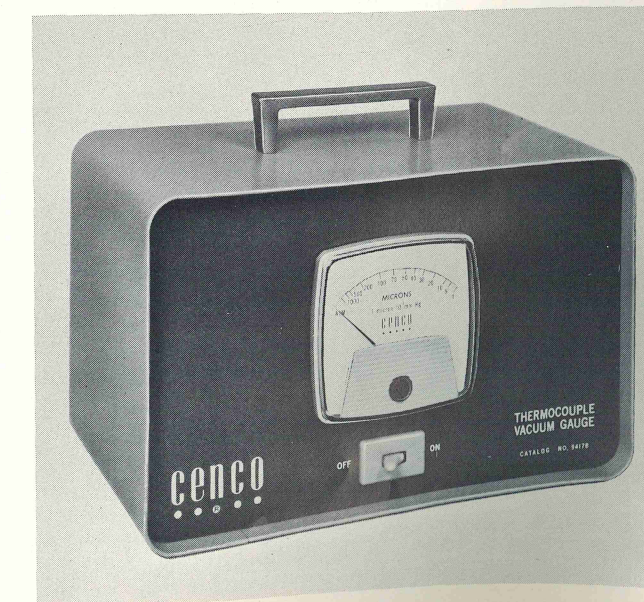
Cenco No.	McLeod Gage No.	O.D. Connecting Tube
94165-3	94160	10 mm
94165-4	94156	18-19 mm
94165-5	94151	10 mm



Cenco Thermocouple Vacuum Gage

Measures pressures in the range of 1 to 1000 millitorr and reads directly on a single meter scale. Adjusted and calibrated for immediate use, this lightweight gage responds to both condensable and non-condensable gases. The all-metal thermocouple tube resists contamination, physical shock and may be operated at atmospheric pressure. The gage tube has a standard 1/8" NPT male thread, is 5 1/4" long and 1" in diameter. A 5-foot, plastic covered, 4-wire cable with octal socket is supplied for connecting the thermocouple tube to the Thermocouple Gage supply. A separate meter is not required for the heater current. A constant voltage transformer accommodates line voltage variations. The unit is 10 1/4" long, 6 1/2" high and 5 1/2" deep. Attractively finished in blue and beige enamel. Available for operation from either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Supplied with a 3-wire cord and plug for positive electrical connections. Shipping weight is 12 pounds.

No. 94178-1, 115 volt, 60 cycle, ac
No. 94178-8, 230 volt, 50 cycle, ac



Cenco Discharge Gage

Continuous and direct pressure readings from all condensable vapors and permanent gases present in a vacuum system are indicated on a single meter scale. Measures vacuum continuously from 0.001 millitorr to 20 millitorr. The calibration is standardized with a McLeod Gage using dry air. The Discharge Vacuum Gage includes a transistorized dc amplifier and relay to operate auxiliary equipment such as pumps, heaters, etc., at any desired pressure on the scale. Both normally-open and normally-closed contacts are provided through banana jacks on the front panel, permitting the apparatus to be started and stopped at a given pressure. A built-in regulating transformer accommodates line voltage variations.

The open end of the discharge tube, 1" OD, is connected into the vacuum system by means of suitable vacuum fittings, gage ports, etc. A 6-foot, plastic-covered, coaxial wire with connector is supplied for attaching the discharge tube to the Discharge Vacuum Gage.



The Discharge Gage is 16 1/4" long, 7 1/2" high and 6 3/4" deep. Attractively finished in blue and beige enamel. Available for either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Relay contacts are rated for 1 ampere. For heavier loads, a No. 99720-1 or 99725 relay may be used. Supplied with a 3-wire line cord and plug for ground connections. Shipping weight is 15 pounds.

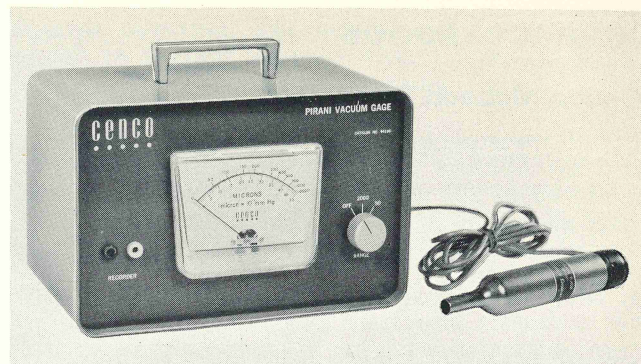
No. 94183-1, 115 volt, 60 cycle, ac
No. 94183-8, 230 volt, 50 cycle, ac

Discharge Tube

A cold-cathode glow-discharge type for replacement in No. 94183 Discharge Gage.
No. 94187

Cenco Pirani Gage

The Cenco Pirani Vacuum Gage, a thermal conductivity type, is based on the temperature and/or resistance change of a heated filament. This change or unbalance is measured on a conventional wheatstone bridge circuit. One arm of the bridge utilizes a compensating tube, sealed under vacuum, to make the circuit insensitive to ambient temperature changes. Pressure is continuously read on a meter having two scales calibrated to the bridge unbalance. One range is 0 to 50 x 10⁻³ torr, and the other is 50 x 10⁻³ torr to 2 torr. The power supply is a full wave bridge rectifier using a constant voltage source. This makes the instrument very stable. Two banana jacks are located on the front panel for recorder use.



Zero drift, which can be a serious problem in Pirani Gages, has been corrected to a great extent by operation of a filament at a much lower temperature (a maximum of 250° C. at a pressure well below 1.0 millitorr) and by inorganic treatment of the filament to provide a stable, inorganic, black surface. The Pirani tube is 7" long with an envelope OD of 1 1/4" and a tubulation OD of 1/2". The Cenco Pirani Vacuum Gage is 10 1/4" long, 6 1/2" high, and 5 1/2" deep. Attractively finished in blue and beige enamel, it is available for 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. The power consumption is 12 watts. Net weight is 8 pounds.

No. 94190-1, 115 volt, 60 cycle
No. 94190-8, 230 volt, 50 cycle

Cenco Ionization Gage

This excellent Ionization Gage incorporates a wide range electrometer amplifier and is designed for use with Bayard-Alpert inverted ionization gage tubes. With it, dry air pressure measurements can be made in the range from 1 x 10⁻³ to 2 x 10⁻¹⁰ torr.

Circuitry

Six separate circuits are used in the Cenco Ionization Gage: a power supply, an electrometer type ion current amplifier, an over-pressure protective circuit, an emission current regulator, a grid outgassing circuit and a recorder output circuit. The amplifier has near 100% negative feedback to provide excellent stability in reading the ion currents from the gage tube collector. The protective circuit controls the filament circuit and, in the event of an overpressure condition, turns the filament off.

The emission regulator is a constant current device with a wide range of adjustments permitting gage tubes with different sensitivities to be used without the need for time-consuming recalibration of the amplifier. The regulator corrects for line voltage fluctuations, pressure changes, and emitter work function changes. The grid outgas circuit supplies current to the grid of the ionization gage tube to bring the grid to a bright red heat for outgassing of the gage tube walls. The recorder output is variable between 0 and 10 millivolts for full scale reading of the pressure meter.



Simplified Control Panel

Controls are grouped for easy reading and use. The pressure gage is calibrated in 100 divisions from 0 to 10. A six decade range switch can be set for readings from 10⁻³ to 10⁻¹⁰. Filament-on-and-off switches have built-in pilot lamps. The outgas circuit switch and emission gage are also mounted on the front panel.

Controller Model

The No. 94198 is provided with a SPDT, 3-ampere, contact meter relay that can be set to turn auxiliary equipment on or off at any pre-set pressure within the range of the gage. A setting control is provided on the front panel.



Specifications

OPERATING RANGE, torr	1 x 10 ⁻³ to 2 x 10 ⁻¹⁰
ZERO DRIFT, % of full scale	2
OVERPRESSURE CIRCUIT, % of full scale	125
OPERATING VOLTAGE	115, 60 cycle
WATTAGE	
Operating	67
Outgassing	110

Gages are supplied with a 3-wire line cord and plug for connection to a power line, a 4-wire gage power cable, and a coaxial cable for ion collection.

No. 94197 without controller
No. 94198 with controller

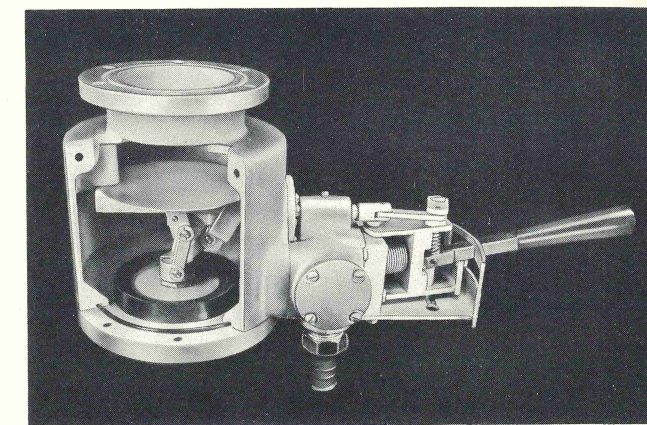
Ionization Gage Tubes

Hot filament tubes for use with the Nos. 94197 and 94198 Ionization Gages. All types utilize the Bayard-Alpert inverted element configuration and are suitable for measuring pressure in the range from 10⁻³ to 10⁻¹⁰ torr. The tubes are provided with three filaments that can be used separately or collectively to allow for both longer tube life and higher gage sensitivity when using higher electron currents to the grid. Tube sensitivity is 60 microamperes per micron when using 5 milliamperes grid current or 100 microamperes when using 8 1/3 ma grid current. Four types are available, three with tubulation enclosed filaments and one with filaments exposed for extremely accurate readings. Connections are provided to outgas the grid structure by passing current through the grid element.

No. 94195-1 With 3/4-inch Nonex tubulation
No. 94195-2 With 3/4-inch Pyrex tubulation
No. 94195-3 With 3/4-inch Kovar tubulation
No. 94196 Without tubulation

Cenco Three-Way Vacuum Valve

Designed to serve as a master control in high vacuum systems employing a diffusion pump and a mechanical pump. It replaces the roughing, foreline and high-vacuum valves now being used in conventional systems. With this valve, the evacuated chamber may be quickly isolated from and connected back into the pumping system without shutting down the pumps. Rapid single lever action facilitates positive mechanical switching to each of three operating positions: "Closed," "Rough Down," and "Diffusion Pump." This direct mechanical movement eliminates problems associated with solenoid operated and hydraulic or pneumatic mechanisms. A water-cooled baffle is included to minimize backstreaming from the diffusion pump. The control lever extends 6" beyond the detent mechanism to provide convenient operation when the valve is mounted beneath a large baseplate or behind a panel.



Flow Passages. All passages provide full pipe area throughout. Throat openings for the main valve are 4 inches in diameter. Passages for the foreline and roughing line are equivalent to 1 inch pipe.

Outgassing. Minimum outgassing time is required as only materials with low-vapor pressure are used for seals. Special attention has also been given in construction to eliminate "virtual leaks."

Vacuum Tightness. The valve body and end plates are cast of close grained aluminum and vacuum impregnated after machining to assure tightness. Metallic bellows are used to seal the two movable links and rubber rings are employed at the fixed joints. The three valve disks consist of metal plates with integrally molded rubber sealing lips.

Connections. Six 1 3/32" diameter holes equally spaced on 5 1/4" diameter bolt circle are provided to attach the valve to a pump plate. To connect a diffusion pump, six 3/8-24 UNF x 1/2" deep holes equally spaced on 5 1/4" diameter bolt circle are provided. Foreline and roughing lines are connected on two nipples for 1" I.D. rubber hose. Connect 90° elbow nipple to diffusion pump outlet and straight nipple to mechanical pump. To connect the water lines, rubber tubing or ordinary 3/8" diameter copper tubing with compression type fittings may be used. The valve cooling coil may be connected in series (but in front of) the cooling coil on the diffusion pump or to an individual water source. Shipping weight is 35 lbs.
No. 94552

Cenco Liquid Nitrogen Traps

For use in vacuum systems to condense moisture and oil vapors without materially retarding system conductance. The traps consist basically of two concentric metal tubes, top and bottom plates, a vacuum cap and inlet nipple. The bottom plate has a Teflon O-ring seal to permit periodic draining of the condensate to the collector tube. From here, condensate can be emptied simply by removing the threaded cap at the bottom of the trap. In operation, the syphon tube is connected to a vacuum pump and the collection tube to the system being evacuated. Connections can be made with either rubber tubing or with metal tubing for permanent installations. A Dewar-type flask with a suitable coolant such as liquid nitrogen or dry-ice-alcohol is required to condense the vapors in the collector tube. Cenco No. 15830-4 Dewar Flask is recommended for all sizes of traps. The traps are available in a choice of welded aluminum or silver-soldered stainless steel. All types have an overall length of 12 inches and an effective trap length of 7½ inches.

Cenco No.	Syphon Tube and Intake Nipple O.D.	Collector Tube O.D.	Cenco No.	Syphon Tube and Intake Nipple O.D.	Collector Tube O.D.
Aluminum			Stainless Stl.		
94009-1	1"*	2"	94009-4	1"*	2"
94009-2	1¼"***	2¼"	94009-5	1¼"***	2¼"
94009-3	1¾"***	3"	94009-6	1¾"***	3"

*For ¾" water tubing, ⅝" mechanical tubing or 1" rubber tubing.
 **For 1" water tubing, 1⅝" mechanical tubing or 1¼" rubber tubing.
 ***For 1½" water tubing, 1⅞" mechanical tubing or 1¾" rubber tubing.

Exhaust Filters

Easy to install and long lasting, these filters trap oil vapors and oil droplets which may be exhausted from mechanical pumps. The filter consists of several layers of a non-organic fiber. Oil which is separated from the air at the pump exhaust port is drained back into the pump. Available in four sizes to fit most Cenco Vacuum Pumps.

Cenco No.	Inlet Connection	Capacity CFM	For Use with
93126-1	½" IPS	5	Hyvac 2* Hyvac 7 (Single or Two-Stage) Megavac
93126-2	¾" IPS	10	Hyvac 14 (Single or Two-Stage)
93126-3	1½" IPS	20	Hyvac 28 (Two-Stage only) Hyvac 45
93126-4	3" IPS	100	Hyvac 150, 225, 300

*Requires No. 93122 Adapter



Filter Elements

Replaceable filter elements for the No. 93126 Exhaust Filters listed above.

Cat. No.	Fits Filter No.	Cat. No.	Fits Filter No.
93127-1	93126-1	93127-3	93126-3
93127-2	93126-2	93127-4	93126-4

Light Grade, Cenco-Hyvac Vacuum Pump Oil

The development of Cenco-Hyvac Oil is the result of exhaustive tests made in the Cenco laboratories. The oil incorporates two essential high vacuum characteristics: A low vapor pressure which does not materially increase at temperatures up to 50° C., and a viscosity sufficiently low for use at 15° C. that remains fairly constant up to 50° C. This oil should always be used to achieve the guaranteed performance of Cenco oil-sealed pumps.

Cenco No.	Size	Case Quantity
93050-2	1 quart	12
93050-3	1 gallon	6
93050-4	5 gallons	6

Sylphon Packless High Vacuum Valve

With special seat for use in high vacuum systems where part of the system must be occasionally exposed to the atmosphere. A "Teflon" disk valve with stem enclosed in metallic sylphon-type bellows prevents the entrance of air through the valve stem bushings. Connections are made with standard pipe of appropriate size.

Cenco No.	Connection Size	Over-All Height	Length Between Connections
94551-1	1"	7⅞"	4¼"
94551-2	1½"	8¼"	4⅝"

Low Pressure Solenoid Valve

For use on the intake port of Cenco Vacuum Pumps to automatically close off the evacuated system when the motor is stopped. The bodies are of aluminum finished in blue-gray hammertone, with stainless steel valve seat and armature pilot plunger. Valve diaphragm is of special synthetic rubber which withstands temperatures to 180°F. The rim of the diaphragm serves as a gasket, assuring correct alignment of assembly. Holding power consumption is 10 watts. Maximum operating range 15 lb./sq. in. Supplied with proper size close nipple to attach the valve to the pump intake after the regularly supplied nipple or coupling has been removed. No. 93062 Vacuum Sealing Compound should be used to seal the threads at the pump connection and the nipple or the coupling at the top of the valve. Nine sizes are available. Size 1 for Hyvac 2 Pumps; Sizes 2 and 3 for Hyvac 7, Pressovac, and Megavac Pumps; Sizes 4 and 5 for Hyvac 14, Hypervac 23 and Hypervac 25 Pumps; Sizes 6 and 7 for Hyvac 28 Pumps; Sizes 10 and 11 for Hyvac 45 Pumps.

IPS Thread, Inches				IPS Thread, Inches			
Cenco No.	Inches	Volts	Cycles	Cenco No.	Inches	Volts	Cycles
94280-1	⅜	115	50/60	94280-6	1	115	60
94280-2	½	115	50/60	94280-7	1	230	60
94280-3	½	230	50/60	94280-10	1½	115	60
94280-4	¾	115	50/60	94280-11	1½	230	60
94280-5	¾	230	50/60				

Extra Heavy Wall, Red Tubing, Cenco

For filter and vacuum pump connections, mercury leveling bulbs, etc. Made to our special formula for high-vacuum work. Sold in minimum lengths of 5 feet in sizes 1 to 3 and 1 foot in sizes 6 to 11.

No. 18204	1	2	3	6	8	11
Dash No.						
ID, inch	⅛	⅜	¼	⅜	⅝	⅞
Wall thickness, inch	⅜	⅜	⅜	⅜	⅜	⅜

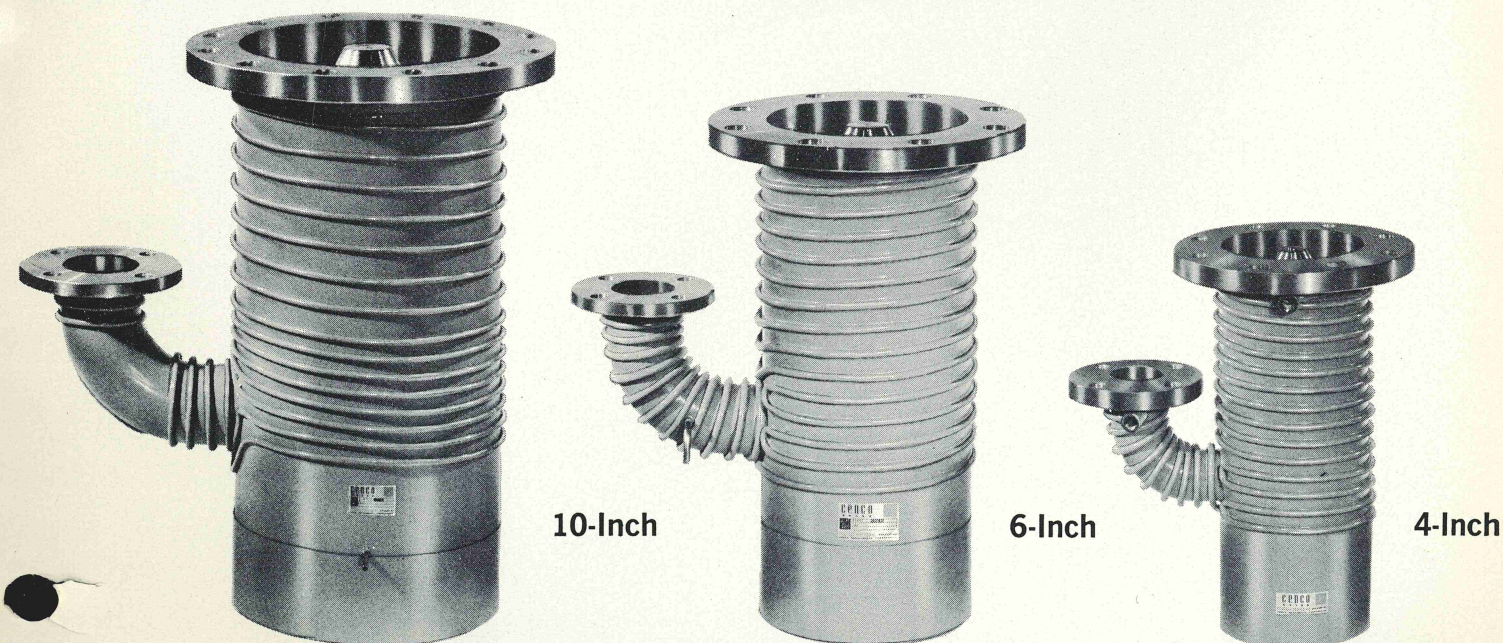
Cenco High-Speed Diffusion Pumps

Operating Specifications	4-Inch Pump	6-Inch Pump	10-Inch Pump
MAXIMUM PUMPING SPEED, liters per second	1000	2000	4500
OPERATING PRESSURE, torr (mm of Hg)	From 2 x 10 ⁻³ to less than 1 x 10 ⁻⁹		
LIMITING FOREPRESSURE, torr			
At full load	0.65	0.50	0.45
At no load	0.80	0.70	0.60
PUMP FLUID			
Recommended Cenco No.	93264	93264	93264
Quantity, cc	395	630	1815
COOLING WATER REQUIREMENTS, gallons per min. at 20°C	0.25	0.40	0.75
HEATER			
Voltage	115	115	230
Wattage	1200	1800	3600
FOREPUMP REQUIREMENTS, Cubic ft. per minute	5	10	25
RECOMMENDED FOREPUMP	HYVAC 14	HYVAC 28	HYVAC 150

Pumps are available with either stainless steel bodies and flanges for maximum service or with more moderately priced carbon steel bodies and flanges. Both stainless steel and carbon steel models are furnished complete as described with stainless steel jets but without pumping fluid, powerstat or forepump. For complete dimensional details and specifications, refer to the tables on this page.

Ordering Guide

Cenco No.	Pump Type	Size	Cenco No.	Pump Type	Size
93405	Stainless Steel	4-Inch	93411	Carbon Steel	6-Inch
93406	Carbon Steel	4-Inch	93415	Stainless Steel	10-Inch
93410	Stainless Steel	6-Inch	93416	Carbon Steel	10-Inch



9 bibliography

In addition to the publications below, literature on vacuum equipment can be obtained from Central Scientific Company, 1700 West Irving Park Road, Chicago 13, Illinois.

Davy, John R., *Industrial High Vacuum*, London, Pitman and sons, 1951.

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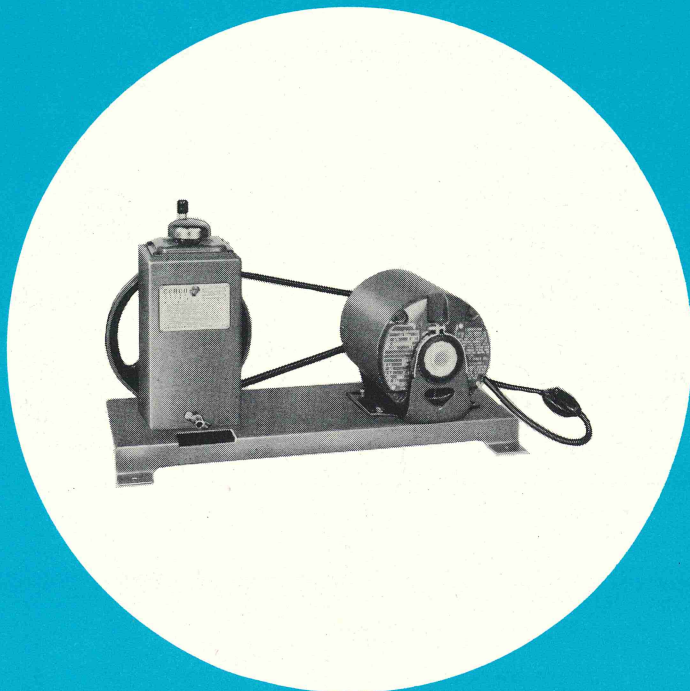
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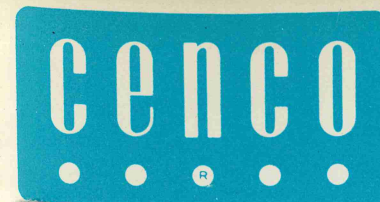
* Research conducted in the vacuum laboratory of Central Scientific Company.

CENCO HYVAC PUMP



A two-stage, oil sealed mechanical pump of the internal moving vane design for pumping down to 0.3 microns of vacuum with moderate speed. Its reasonable cost and size make this dependable pump ideal for research and educational laboratory applications. It has also found wide acceptance in the chemical process industry where a continuous high vacuum is required.

\$119.00

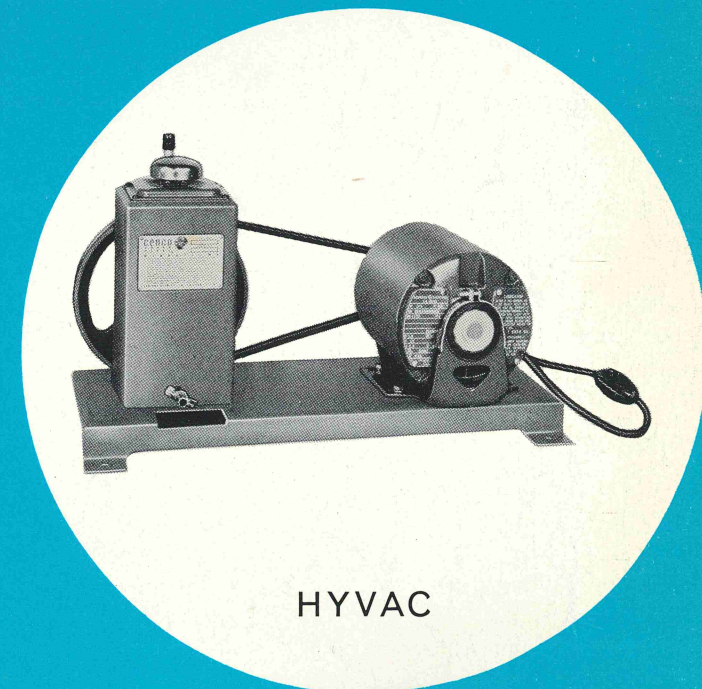


1700 W. IRVING PK. RD. CHICAGO 13, ILL.
CENTRAL SCIENTIFIC COMPANY

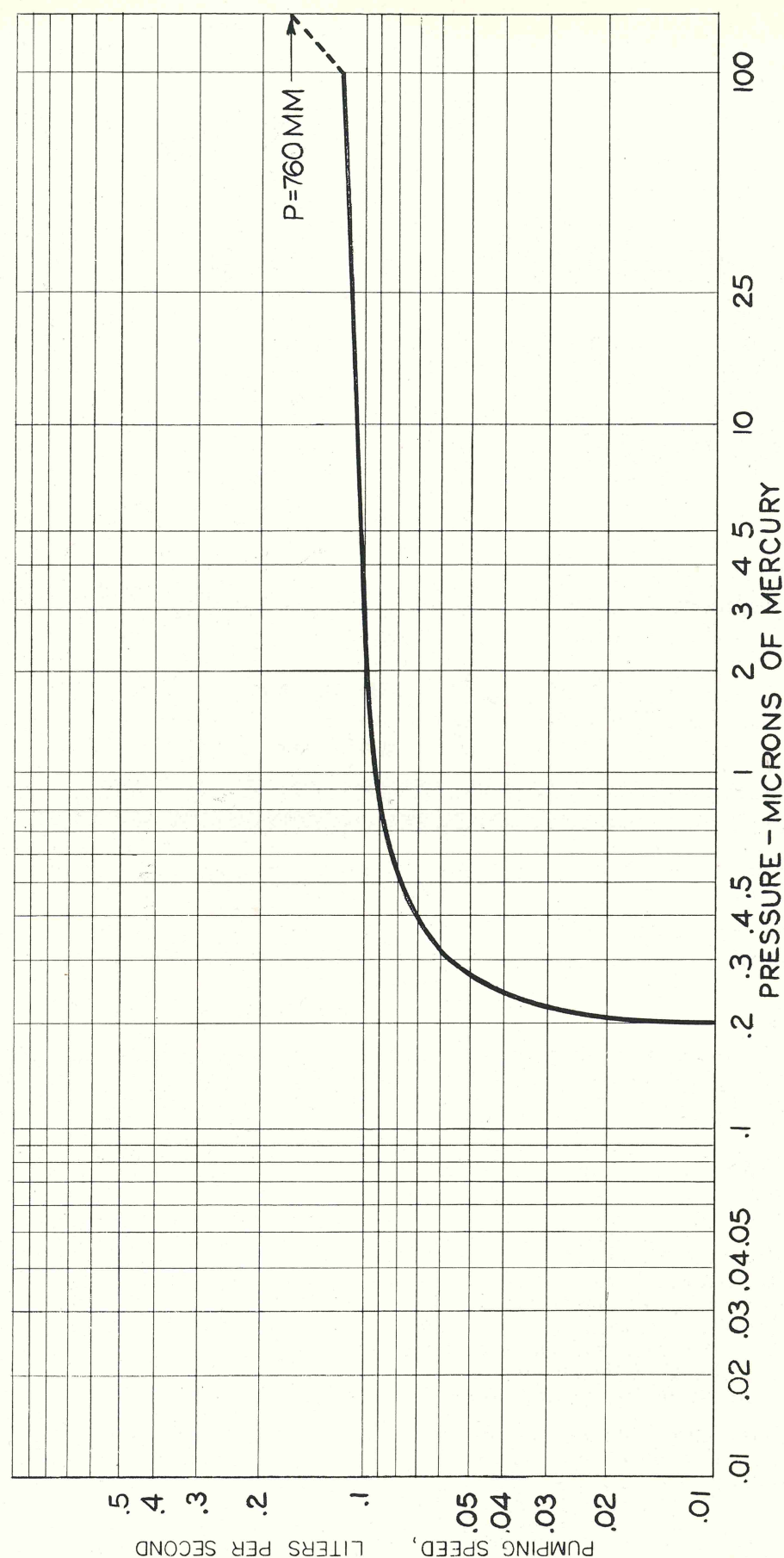
mechanical vacuum pumps

A COMPLETE LINE OF HIGH VACUUM PUMPS, GAGES, SYSTEMS, & COMPONENTS
MAKERS OF THE WORLD RENOWNED HYVAC® PUMPS

	GUARANTEED VACUUM (microns of mercury)	CAPACITY at atmosphere at 1 micron (liters per min.) (liters per min.)		BOOKLET
Hyvac	0.3	10	5	320
Hyvac 2	0.1	20	9	321
Hyvac 7	0.1	70	30	
Hyvac 14	0.1	140	60	
Hyvac S14	10.0	140	—	322
Megavac	0.1	57	22	323
Hypervac 23	5.0	240	—	324
Hypervac 25	0.1	264	120	
Hypervac 100	0.1	960	660	
Pressovac 93033	25.0	35	—	325
Blower Pump	3 IN. Hg	35	—	326



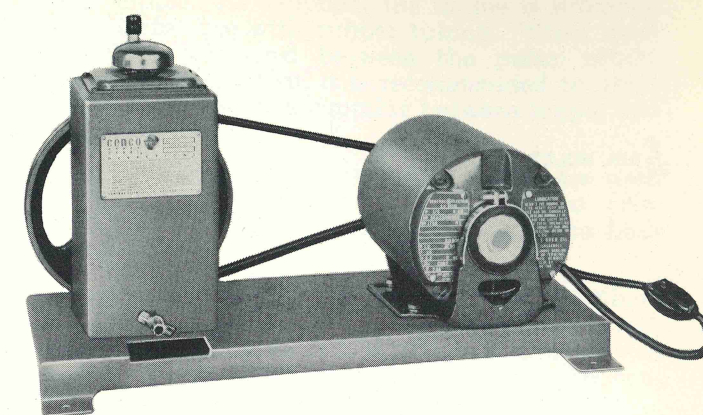
HYVAC



1.4 pump, mounted with motor

The Hyvac Pump, Cenco No. 91105, is assembled on a steel base and supplied with motor and a belt drive.

Cenco Cat. No.	Motor Rating
91105-1	115 V, 60 cycle, 1 phase, 1/4 hp.
91105-2	230 V, 60 cycle, 1 phase, 1/4 hp.
91105-3	115 V, DC, 1/4 hp.
91105-4	230 V, DC, 1/4 hp.
91105-5	115 V, 25 cycle, 1 phase, 1/4 hp.
91105-7	115 V, 50 cycle, 1 phase, 1/4 hp.
91105-8	230 V, 50 cycle, 1 phase, 1/4 hp.
91105-10	115 V, 60 cycle, 1 phase, 1/4 hp. Explosion proof
91105-23	No motor supplied, otherwise same



2 installation

2.1 mounting

If the mounted pump is obtained, the pump is immediately ready for use.

If an unmounted pump is obtained, the pump should be mounted on a flat, rigid, steel or cast-iron base, such as supplied with the mounted unit as shown in Fig. 2. Provisions should be made for bolting the base to the floor or, if used in a movable unit, to the frame. When electronic equipment is attached to the same frame Shock mounts should be obtained so that vibrations from the motor or pump will not be transmitted through the frame.

A belt drive connects the motor with the pump. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump. The best operating speed is 350 rpm, although a variation in speed between 300 and 600 rpm will only change the volumetric speed of the pump. The major dimensions of the pump, pump base and motor are given in Fig. 2.

2.2 motor connection

Motors have a connecting 3 conductor grounded cord and plug attached (except Cenco Nos. 91105-10 and 91105-23). In all cases, connect the motor to a powerline of the voltage frequency and phase as indicated on the nameplate of the motor. The powerline should be heavy enough to carry the current required without an undue drop in voltage. All motors may be operated on "across the line" start. Remember that fuses provide short circuit protection only for the power supply line and do not protect the motor from overload. It is recommended that a suitable starting switch with motor overload protection be used for all permanent installations.

For correct selection of the fuse, consult the list below:

Cenco Pump No.	Current at full load (amperes)	Max. fuse rating (amperes)
91105-1	5.6	20
91105-2	2.8	15
91105-3	2.5	15
91105-4	1.3	15
91105-5	4.0	15
91105-7	5.4	15
91105-8	2.7	15
91105-10	4.2	15

2.3 vacuum connections

When connecting the pump to the system to be evacuated, extreme care must be taken to eliminate leakage. All connections should be as short as possible, and of large diameter to reduce molecular friction. When the pump is operating in the low micron range, the flow of gas through a tube is substantially molecular in character. At low pressures, the gas removed from the system is confined largely to those molecules which, because of their kinetic energy of agitation, happen to hit the intake of the pump when the cylinder of the pump is open to the intake. The conductance of various size tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008 or may be determined from Fig. 3, in which $(L + \frac{4}{3}D)$ is plotted against Z, the conductance in cubic centimeters per second. L and D are the length and inside diameter of the tubes in centimeters.

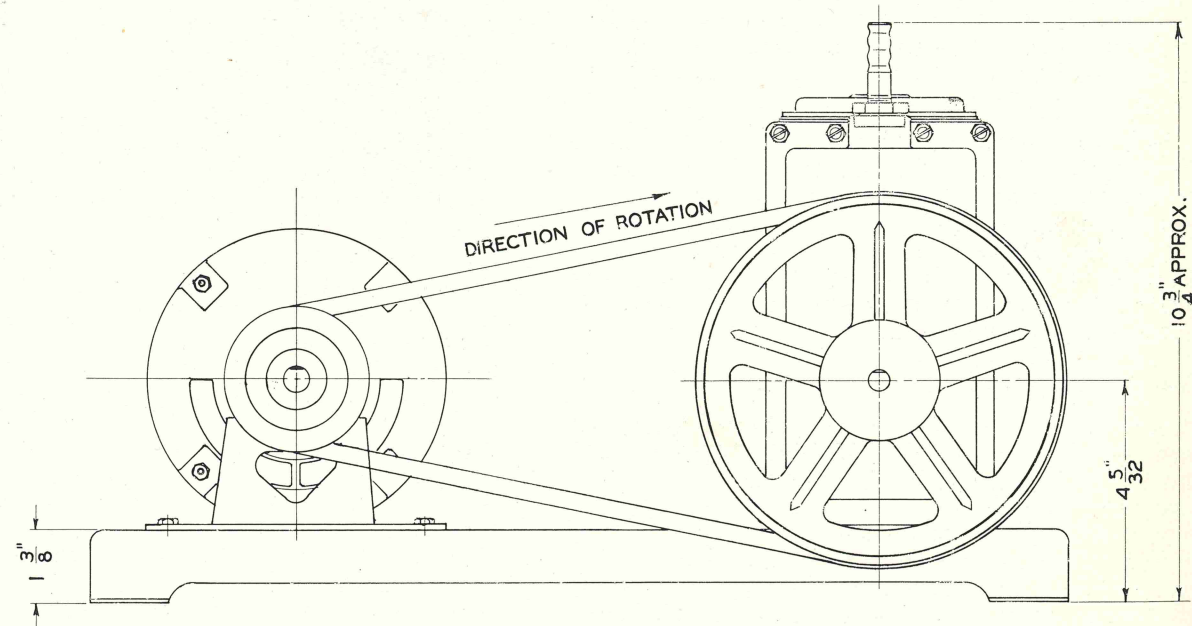
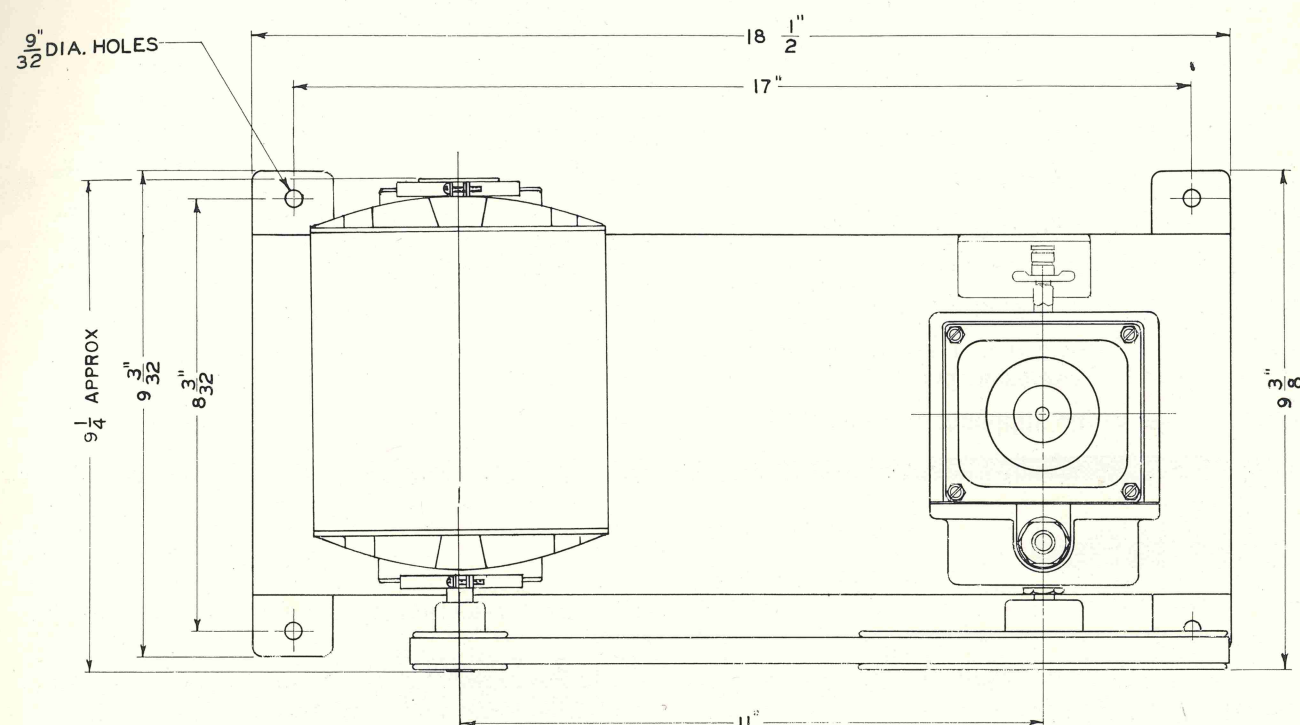


Fig. 2, Outline Hyvac Pump

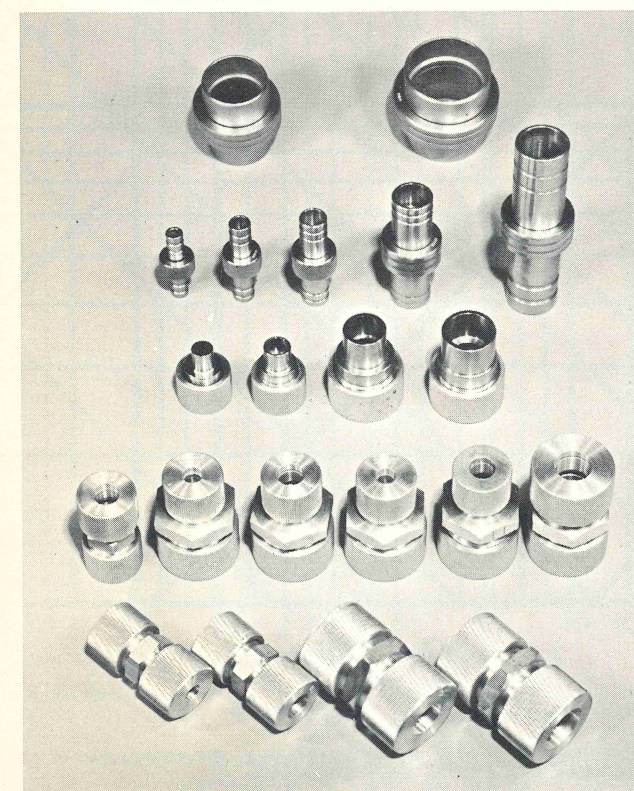
The net speed of the system then may be found by the following relationship:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pump speed taken from Fig. 1 and Z is the conductance of the tubing.

If metal piping is used, it is best to solder or braze all connections. When threaded pipe joints must be used, the threads should be as perfect as possible. In such a connection, screw the members together several turns, and then apply Glyptal to the exposed threads before screwing together tightly. Allow the Glyptal to dry several hours before starting the pump. If flanged connections are used, flat or O-ring gaskets made of rubber or Neoprene should be used between the flanges to eliminate leakage. Place a thin coat of oil on the "O" ring before using. Cenco manufactures an extensive line of couplings, connectors and accessories for use in high vacuum systems (see Cenco Booklet 327). Some of these are:

Cenco No.	Name	For Tubing	Size Range
94226	straight through	glass and/or metal	3/8" - 1"
94235	straight through	metal and/or rubber	1/4" - 2"
94228	reducing	glass and/or metal	3/8" - 1"
94230	connectors	metal-to-glass	3/8" - 1"
94240	caps	for 94235	1/4" - 2"
94245	nipples	rubber	3/8" - 1 3/16"



Typical Cenco Vacuum Connectors

The Hyvac pump is provided with a one-piece intake nipple. As supplied, the nipple is intended primarily for use with rubber tubing. When glass connections are used between the pump intake nipple and the system, it is recommended to use a short rubber hose as a coupling between nipple and glass tube.

When tapered glass joints or ball joints are used in connections, a vacuum stopcock grease (No. 15517-1 or No. 15522) should be applied to both members.

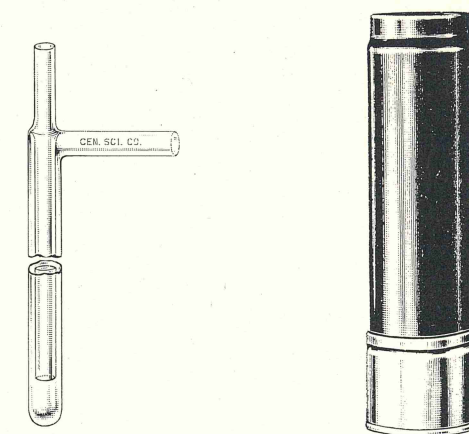
Rubber tubing connections should be kept as short as possible and made with an extra heavy wall, gum tubing, such as No. 18204, which has been compounded specially for vacuum work. All connections to metal or glass tubing should fit snugly and both members should be coated with vacuum stopcock grease.

2.4 valves

Metal vacuum valves and glass stopcocks are employed generally in the connecting line between the pump and the system to provide a means of connecting the vacuum gage and for vacuum release when stopping the pumping. When metal pipes are used for the line, a high-vacuum valve such as No. 94551 is recommended.

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of testing the pump, and system for leaks by the "pressure rise" method without disconnecting the pump from the line.

2.5 traps



No. 94005 liquid air trap No. 15830-3 Dewar flask

Extreme care must be taken to prevent solid particles from reaching the intake of the pump. They will score the working parts of the pump and reduce its efficiency. If corrosive vapors are in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor from the pump from entering the system. A Cenco No. 94005 or No. 94006 Glass Trap is recommended. Either should be used in a No. 15830-3 Vacuum Flask. The refrigerant most commonly used in the vacuum flask is a mixture of solid carbon dioxide (dry ice) and acetone or ethyl alcohol.

CONDUCTANCE OF TUBES FOR AIR AT 20°C

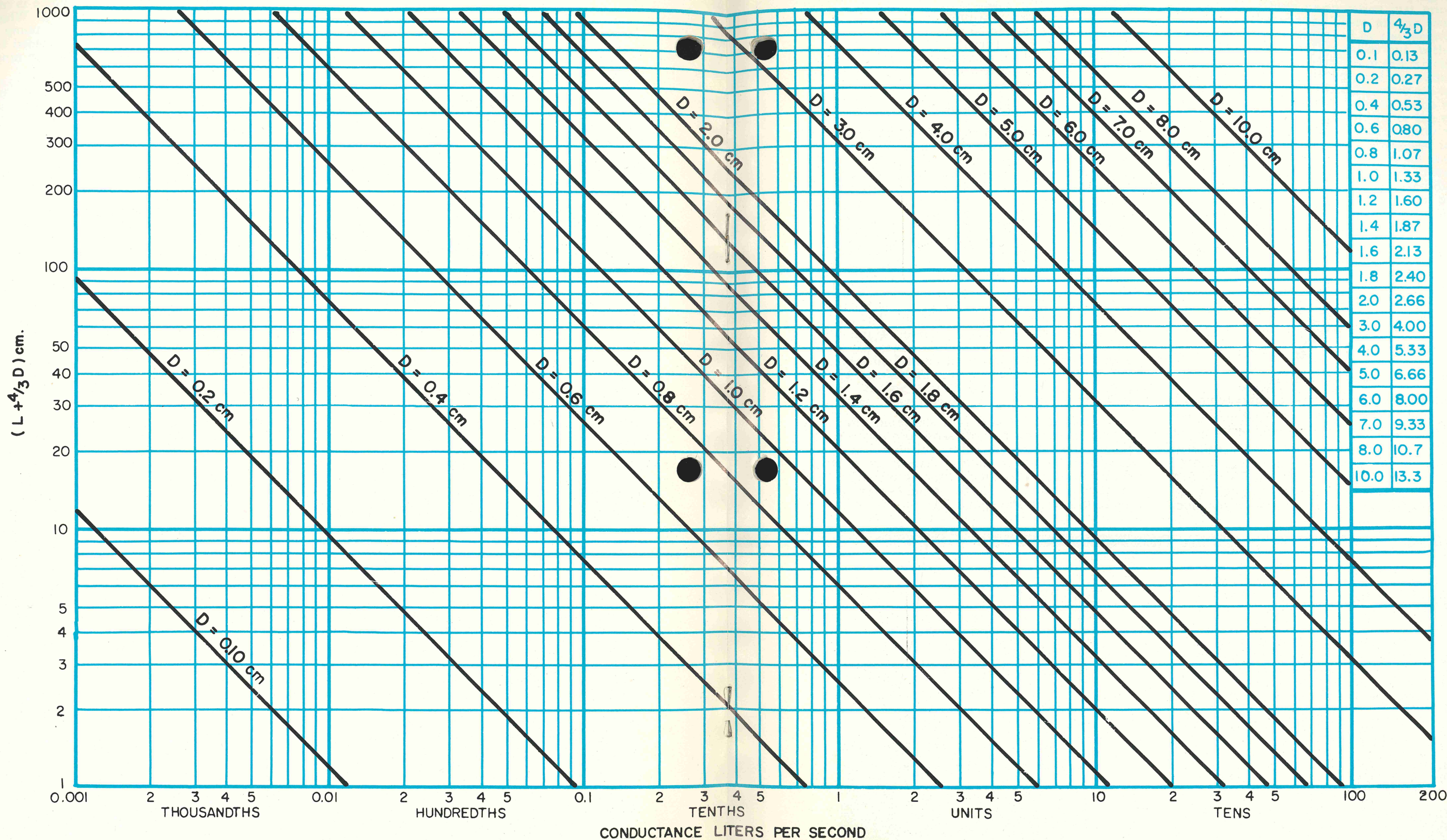


Fig. 3.

TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain pumping speed (S) as large as possible, the tube conductance (Z) must be very large as compared with the speed of the pump (S_1), as is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} \cdot S_1$$

Since at best (S) is only a fraction of (S_1), the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance, (Z), shown in litres/sec, is plotted as abscissas against the quantity ($L + 4/3 D$), in cm., as ordinates. In addition to the parameter D, the value of $4/3 D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the value of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm. long having a diameter of 2 cm. is required. From the table, for D=2, it is seen the $4/3 D = 2.66$ cm. Referring to the curve, for D=2 the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $4/3$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines, spaced logarithmically, conductance of tubes having other diameters than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

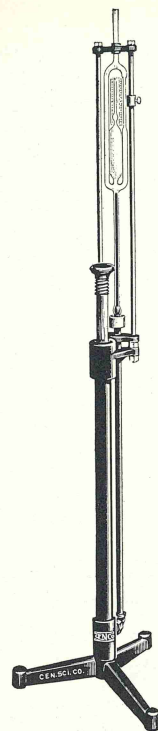
When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely

$$\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$$

where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

2.6 gages



No. 94151 McLeod gage

The types of high vacuum gages commonly used in a system employing a Hyvac pump are the McLeod, Pirani, Discharge, and Thermocouple gage.

A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 mm Hg to 1.6 mm Hg (0.5 microns Hg to 1600 microns Hg). The outlet tube of this gage should be glass-connected to the system between the pump

and the freezing trap by a direct seal or a sealed joint. The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 microns and from 1 to 50 microns of mercury. The Thermocouple gage permits measurements in the range from 1 to 1000 microns of mercury. The Discharge gage operates within the range of 0.001 to 20 microns of mercury.

2.7 oil and drain valve

The oil drain valve is removed during shipment in order to prevent damage. Before adding oil to the pump, remove the pipe plug and replace by means of the drain valve. Best seals will be obtained by applying Glyptal to the drain valve thread before screwing into the pump housing.

The Hyvac is shipped with the oil drained from the reservoir. One quart of oil is supplied with each pump for the first filling and for periodic oil changes. To fill the pump with oil, first remove the exhaust dome and fill through the opening otherwise taken by the exhaust dome up to the oil level sight gage. Turn the pump pulley several revolutions by hand while filling with oil. The oil level window indicates the correct oil level. If insufficient oil is used, a good seal around the vanes may not be maintained. If too much oil is used oil may back up through the pump trap into the vacuum system.

2.8 belt guard

A well designed guard is a desirable protection against personnel hazards, and also protects the pump from damage caused by objects becoming entangled in the belt or pulley. Cenco pump bases are drilled to receive the guards, and each guard is sold ready for mounting. The order number for this belt guard is given in Paragraph 5.2.

3 operation

When oil has become contaminated it should be changed. The oil may be removed by opening the drain located at the front of the housing. Turn the shaft several revolutions to force out any remaining oil. Flush with clean flushing oil No. 93060 at least once and then refill with new Hyvac Oil No. 93050. The frequency of oil change is dependent upon the service of the pump. An oil change may be needed only once in six months or longer if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosion and easily condensable vapors enter the pump.

Due to the operation of the ball valve in the exhaust stage, Hyvac Pumps normally operate with a clicking sound which becomes sharper as the pump warms up and the pressure reduced.

On continuous duty the oil temperature may reach 50° to 60°C. This is normal for efficient operation of the pump.



4 maintenance

4.1 general

The maintenance requirements of the Cenco Hyvac Pump will vary with application. Proper lubrication is the most important factor in securing reliable performance. (See paragraph 2.7).

If a pump is connected into a normal leak-free system, there should be no condition which should cause the pump to malfunction that cannot be remedied by simple adjustments. If a pump fails to function, the cause usually can be attributed to a broken spring, a sticking vane or worn valve release and not a misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal use, therefore, where no corrosive vapors are encountered, it is reasonable to expect that there will be no decrease in the efficiency of a pump over a period of several years.

4.2 shaft seal

The stuffing-box nut on the pump shaft bearing should be tightened occasionally to take up wear in the packing, thus preventing leakage of oil at this point. New packing may be needed from time to time.

4.3 exhaust valve

It is quite possible, after many hours of pump operation, for the exhaust valve retainer to wear from constant hammering of the ball valve. This will cause the pump to lose efficiency, spray oil and make a pounding noise because the ball valve has either dropped out entirely or is traveling too great a distance. The pump will not reach its guaranteed vacuum due to the fact that oil is continually entering the exhaust opening. The valve retainer and the ball valves can be replaced very easily after removing the pump mechanism from its case.

4.4 vanes

Vanes and springs in the Hyvac Pump can be inspected by removing the top plate. A broken spring will prevent the vane from riding snugly against the rotor during its cycle of operation thus causing a failure in operating efficiency. Vanes may be inspected occasionally but the process must be accomplished with extreme care. The vanes should be removed one at a time and not under any circumstances be interchanged or reversed in position. The vanes may be removed after the springs have been released. By turning the pump by hand, one can determine how much of the vane is protruding above the surface of the pump housing and any markings on this part of the vane will do no harm. It is our practice to pull the vanes out with sharp nosed pliers, but extreme care should be taken to see that the nose of the pliers does not extend down over the part of the surface which slips into the vane slot housing. The vanes might be rather difficult to remove because they are usually under

atmospheric pressure. This is true particularly if the pump has been in operation just prior to the removal of the vanes. There are no loose parts which will become disturbed by the removal of the vanes and these can be taken out without any trouble. Any dirt or particles of grit which may be lodged around the upper part of the vanes should be carefully removed before the vanes are taken out since this material getting into the pump will score the stator as well as the rotor. After the vanes are removed, they may be polished slightly with the very finest of emery paper if they appear to be corroded. The vanes are ground to an established tolerance of 0.0005 of an inch and, therefore, no portion of the metal should be removed during the polishing process. As long as the pump is producing a satisfactory vacuum and no corrosion is present, it is advisable not to polish the vanes.

4.5 belt

The belt adjustment in mounted pumps is made by loosening the bolts in the base of the motor and moving in the required direction. The belt should be just tight enough to prevent slippage while operating. A little slippage on starting is desirable.

4.6 repairs

Fig. 4 shows cross sectional view of the Hyvac Pump. Paragraph 5.1 lists all the parts for the pump. When ordering replacement parts, please state the exact part number. For repairs to the pump other than the replacement of the shaft seal and where adequate shop facilities are not available, it is strongly recommended that the pump be returned to the factory.

Some parts are sold only to customers maintaining adequate shop facilities and experienced mechanics. Cleaning and replacing old parts, unless badly worn, is recommended as safer practice than attempting to refit new parts without the necessary tools and experience. Exhaust and intake vanes are supplied with one side only machined and ground and must be finished to fit the vane slot by the customer if it is impracticable to return the pump to us for repair.

Because of the great difficulty in refitting new rings P60799 and P60800 in order to obtain absolute concentricity of the rotor with respect to the rings, these parts are sold only to pump users thoroughly experienced in pump assembly. Long experience in repairing pumps has proved that rings are seldom worn or damaged to the extent that replacement is necessary. We suggest that the old rings, if not scored or otherwise damaged, be cleaned and reinstalled, with new rotors and vanes, if these latter parts are badly worn.

If pump parts are worn to the extent that new rings are necessary, the pump should be returned to our shop for overhauling and reconditioning. It is quite possible for an experienced mechanic to install new rings, but the task requires a special tool in order to locate dowel positions for drilling and to establish proper concentricity of the rotor with respect to the ring bore.

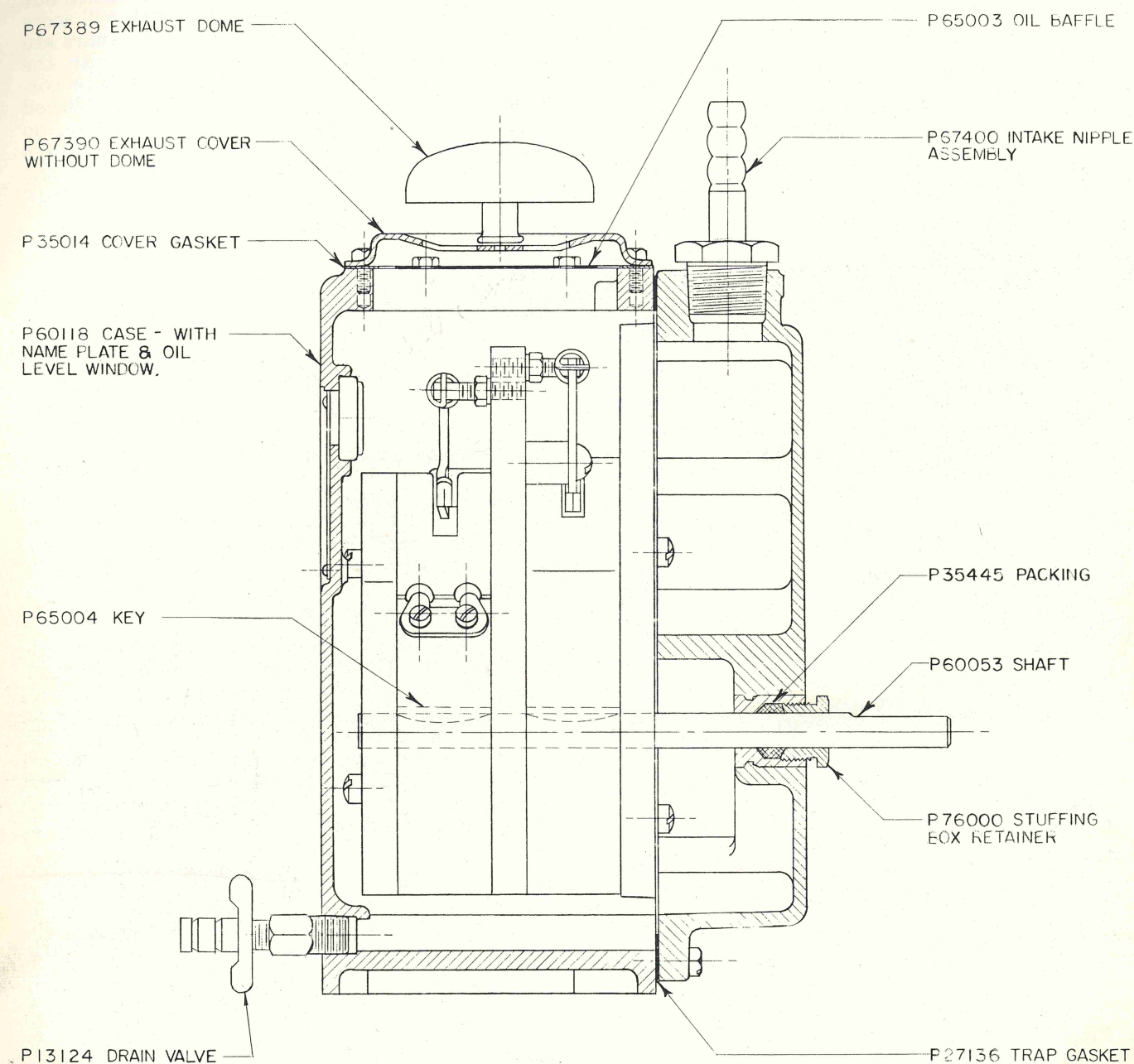


Fig. 4, Sectional View of Hyvac Pump

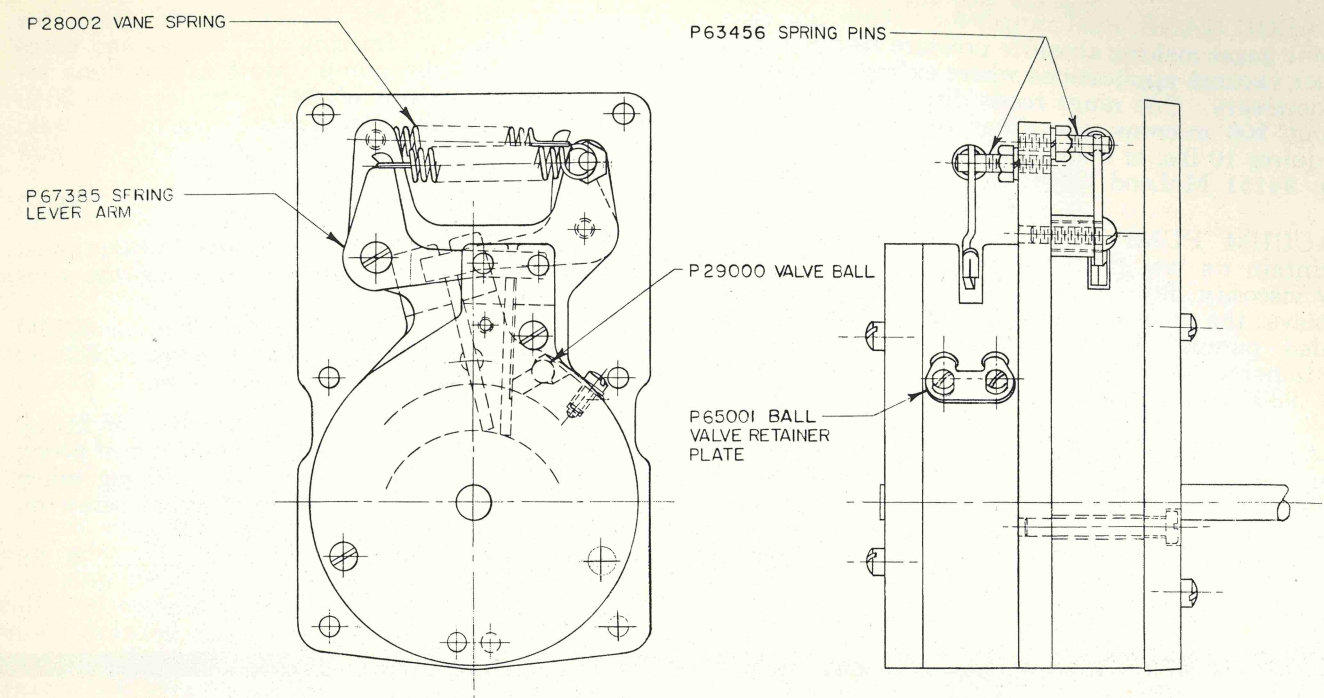


Fig. 5. Spring vanes and valve positions

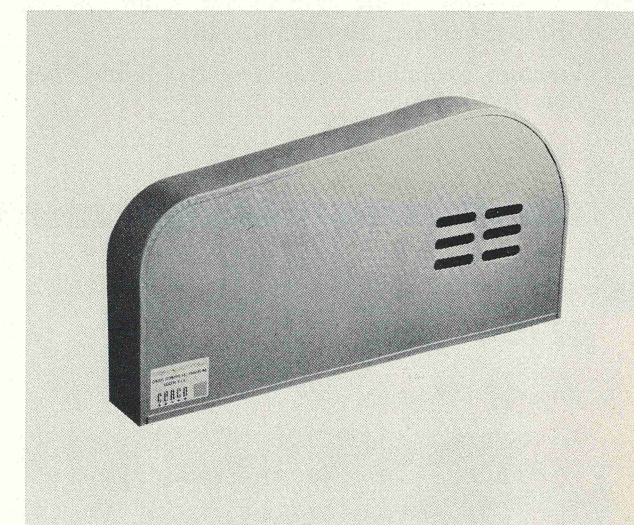
5 replacement parts and accessories

5.1 replacement parts

Part Description	Parts per Pump	Part No.	Prices
² Ring, Exhaust	1	P60800	\$11.00
² Ring, Intake	1	P60799	9.75
² Rotors	2	P60031	7.50
Shaft	1	P60053	2.25
Finished Pump Case (Without Trap) (Complete with Name Plate & Drive Screws for attaching same & Oil Level window).	1	P60118	12.50
² Vane (Intake)	1	P60648	1.50
² Vane (Exhaust)	1	P60649	2.25
Spring Pins	2	P63456	.20
Nipple	1	P63029	1.00
Dome	1	P67389	2.00
Cover (Without Dome)	1	P67390	2.25
Oil Baffle	1	P65003	.15
Spring Lever Arms	2	P67385	1.50
Cover Gasket	1	P35014	.25
(As replacements for pumps with Serial No. 25650 and above. Also can be adapted to pumps with Serial Nos. between 19000 & 25650.)			
Trap Gasket	1	P27136	.50
Packing, Shaft Seal	1	P35445	.30
Key	2	P65004	.40
Stuffing Box Retainer	1	P76000	.50
Vane Springs	2	P28002	.25
Ball Valve Retainer Plate	1	P65001	.10
Valve Balls	2	P29000	.10
Belt	1	91131	2.00
Prices Subject to change			

²Only sold to customers with adequate shop facilities and experienced personnel.

5.2 accessories



BELT GUARD for enclosing the pump and motor pulleys and belts where moving parts constitute a personnel hazard. Comes ready to screw to tapped pump base.

No. 91135 Belt Guard\$14.75

VACU RULE, a handy slide rule for calculating low pressure conductance, system evacuation times, and typical vacuum conversion factors.

No. 94008 Vacu Rule\$1.00

McLEOD GAGE, dual range, for calibrating electronic gages making absolute pressure readings, and other vacuum applications where extreme accuracy is necessary. One range reads directly from 0.5 to about 200 microns, the other to about 1.6 mm. Requires 10 lbs. of mercury.
No. 94151 McLeod Gage\$205.00

VACUUM PUMP OIL especially processed to maintain its low vapor pressure up to 50°C and low viscosity down below 15°C. Must be used to achieve the guaranteed performance of our oil sealed pumps. Also comes in 1 and 5 gallon containers.
No. 93050-2 Light Pump Oil, per quart.....\$.75

FLASK, VACUUM DEWAR TYPE, for use with liquid air traps. Metal base with silvered glass body; 1000 ml capacity, 30 cm inside length, 70 mm inside diameter, made of "Pyrex" brand glass.
No. 15830-3 Vacuum Flask\$12.25

LIQUID AIR TRAP, "Pyrex" brand glass, for either absorbing or "freezing out" vapors and gases before reaching the pump. Most applications require only a mixture of 80% dry ice and 20% alcohol in a Cenco No. 15830-3 Vacuum Flask. Dimensions of trap: 37 cm long, 28 mm OD, 19 mm diameter connecting tubes.
No. 94005 Liquid Air Trap\$6.50

LIQUID AIR TRAP, same as above but equipped with standard taper joint for emptying the condensate.
No. 94006-1, 25 diameter, 12 mm tubes.....\$21.00
No. 94006-3, 30 diameter, 20 mm tubes.....\$23.50
No. 94006-4, 40 diameter, 28 mm tubes.....\$25.50

ADAPTER, 3-PRONG TO 2 PRONG, for fitting three wire, safety male plugs to common two prong 115 volt sockets. Grounding wire and lug allow pump line to be grounded to convenient screw on junction box.
No. 84097 Adapter\$.38

6 bibliography

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Vacuum Technique, Arnold L. Reimann (Chapman Hall Ltd., London) 1952.

Industrial High Vacuum, J. R. Davy (Sir Isaac Pitman & Sons, Ltd.) 1951

7 price list

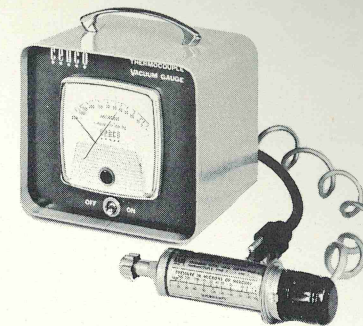
CENCO NO.	MOTOR RATING	PRICE
91105-1	115 V. 60 Cycle	\$119.00
91105-2	230 V. 60 Cycle	129.25
91105-3	115 V. D.C.	171.00
91105-4	230 V. D.C.	165.50
91105-5	115 V. 25 Cycle	150.00
91105-7	115 V. 50 Cycle	129.25
91105-8	230 V. 50 Cycle	134.50
91105-10	115 V. 60 Cycle	150.00
91105-23	(explosion proof) Without Motor	101.00

high vacuum gages

THERMOCOUPLE VACUUM GAGE for measuring pressures in the range of 1 to 1000 microns of mercury, read directly on a single meter scale. Gage head is shock resistant and cannot be damaged by exposure to atmospheric pressure. Voltage regulation circuit makes this light weight unit insensitive to operating line voltage changes (115 volts, 60 cycles A.C.).
No. 94178 Thermocouple Gage\$110.00

DISCHARGE VACUUM GAGE AND CONTROLLER for direct reading of pressures between .001 and 20 microns of mercury on a single scale. Gage head is shock resistant and unaffected by atmospheric pressure. Transistor amplifier circuit activates relay at any pre-set pressures to either start or stop auxiliary equipment. Operates on 115 volts, 60 cycle A.C. and will control external equipment drawing up to 1 ampere without having to use relays (Cenco Nos. 99720-1 or 99725).
No. 94183 Discharge Gage\$249.50

PIRANI GAGE, improved design based on hot-wire principles, for direct readings from 1 to 2000 microns of mercury in two scales. Measures total pressure of condensable vapors and gases in the complete system. Output for 10 millivolt recorder. Operates on 15 watts, 115 volts, 60 cycle A.C.
No. 94185 Pirani Gage\$196.00

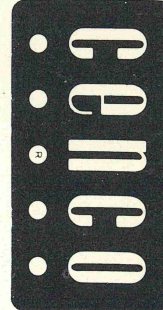


THERMOCOUPLE



DISCHARGE

SHIP TO:				Institution, Company, or Individual				Date of Order			
ATTN:				City				State			
CHARGE TO:				Institution, Company, or Individual				Order Number			
ATTN:				City				State			
Street Address				City				State			
GTY.				CAT. NO.				ARTICLE			
PRICE				EXT.							



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Along Dotted Line

Booklet 320

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		10	6-17-64	1	1	X YES	NO		P90540	
REV.		ISSUE DATE	SHEETS	SHEET	DRAWING		AMT. OF LOT		CENCO NUMBER	SUFFIX
PRESSOVAC PUMP, UNMOUNTED NAME OF ITEM		USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER		
PREPARED JET/SB	CHECKED JET	ENGINEER	APPROVED		E.C.N. 9747					
DESCRIPTION		(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LOT			
ASSIGN SERIAL NUMBER IN P90540 SERIES										
NAME PLATE			P25191		100.00	01				
PLASTIC CAP			P26077		100.00	01				
GASKET			P27136		100.00	01				
TENSION SPRING			P28005	1	100.00	01				
CUP POINT SET SCREW			P29004	1	100.00	01				
SHORT DOWEL PIN			P29173	1	600.00	01				
HOSE NIPPLE			P32168		100.00	01				
COVER GASKET			P35014		100.00	01				
PACKING			P35445		100.00	01				
MOUNTING PLATE			P60014	1	100.00	01				
PRESSOVAC RING			P60015		100.00	01				
PRESSOVAC END PLATE			P60016	1	100.00	01				
PRESSOVAC ROTOR			P60017	1	100.00	01				
PRESSOVAC VANE			P60019	1	100.00	01				
ADJUSTMENT COLLAR			P60024	1	100.00	01				
PRESSOVAC SHAFT			P60088	1	100.00	01				
FINISHED PUMP CASE			P60118		100.00	01				
TRAP			P60764		100.00	01				
SPRING PIN			P63470	1	100.00	01				
OIL BAFFLE			P65003		100.00	01				
SMALL KEY			P65004	1	100.00	01				
VALVE CAGE			P65005	1	100.00	01				
CHECK VALVE RETAINER			P65006	1	100.00	01				
CHECK VALVE			P65007		300.00	01				
OIL BAFFLE			P65448		100.00	01				
SPRING LEVER ASSEMBLY			P67386		100.00	01				
EXHAUST DOME			P67389		100.00	01				
EXHAUST COVER			P67390		100.00	01				
IRON PIPE PLUG			P69160		100.00	01				
SPACER BUSHING			P75506	1	100.00	01				
PACKING NUT			P76000		100.00	01				
WASHER, BRASS			P78700	1	100.00	01				
DRIVE SCREW, STEEL, NO. 0 X 1/8			344800067		400.00	01				
MACHINE SCREW, STEEL, NO. 8-32 X 5/16			344900803	1	200.00	01				
MACHINE SCREW, STEEL, NO. 10-32 X 1/2			344901040	1	100.00	01				
MACHINE SCREW, STEEL, NO. 10-32 X 1-1/2			344901047	1	100.00	01				
MACHINE SCREW, STEEL, NO. 10-32 X 2-3/4			344901052	1	400.00	01				
MACHINE SCREW, STEEL, NO. 10-32 X 3/4			344921042		600.00	01				
SELF TAPPING SCREW, NO. 10 X 7/8			345091009		1200.00	01				
NUT, STEEL, NO. 10-24			345951001		100.00	01				
LOCK WASHER, HELICAL SPRING, STEEL, NO.10			346207010		100.00	01				

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		16	6-11-64	1	1	X YES	NO		P90500	
REV.		ISSUE DATE	SHEETS	SHEET	DRAWING		AMT. OF LOT		CENCO NUMBER	SUFFIX
PRESSOVAC PUMP, UNMOUNTED NAME OF ITEM		USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER		
PREPARED JET/SB	CHECKED JET	ENGINEER	APPROVED		E.C.N. 9747					
DESCRIPTION		(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LOT			
ASSIGN SERIAL NUMBER IN P90500 SERIES										
PRESSOVAC NAME PLATE			P25002		100.00	01				
PLASTIC CAP			P26184		200.00	01				
GASKET			P27136		100.00	01				
TENSION SPRING			P28005	1	100.00	01				
CUP POINT SET SCREW			P29004	1	100.00	01				
SHORT DOWEL PIN			P29173		600.00	01				
PRESSURE RELIEF VALVE			P35011		100.00	01				
COVER GASKET			P35014		100.00	01				
PACKING			P35445		100.00	01				
FINISHED PUMP CASE COVER			P60013		100.00	01				
MOUNTING PLATE			P60014	1	100.00	01				
PRESSOVAC RING			P60015	1	100.00	01				
PRESSOVAC END PLATE			P60016	1	100.00	01				
PRESSOVAC ROTOR			P60017	1	100.00	01				
PRESSOVAC VANE			P60019	1	100.00	01				
ADJUSTMENT COLLAR			P60024	1	100.00	01				
PRESSOVAC SHAFT			P60088	1	100.00	01				
FINISHED PUMP CASE			P60118		100.00	01				
TRAP			P60764		100.00	01				
SPRING PIN			P63470		100.00	01				
OIL BAFFLE			P65003		100.00	01				
SMALL KEY			P65004	1	100.00	01				
VALVE CAGE			P65005	1	100.00	01				
CHECK VALVE RETAINER			P65006	1	100.00	01				
CHECK VALVE			P65007	1	300.00	01				
SPRING LEVER ASSEMBLY			P67386		100.00	01				
INTAKE NIPPLE ASSEMBLY			P67400		100.00	01				
IRON PIPE PLUG			P69160		200.00	01				
HOSE NIPPLE			P69262		100.00	01				
SPACER BUSHING			P75506	1	100.00	01				
PACKING NUT			P76000		100.00	01				
WASHER, BRASS			P78700	1	100.00	01				
DRIVE SCREW, STEEL, NO. 0 X 1/8			344800067		400.00	01				
MACHINE SCREW, STEEL, NO. 8-32 X 5/16			344900803	1	200.00	01				
MACHINE SCREW, STEEL, NO. 10-32 X 1/2			344901040	1	100.00	01				
MACHINE SCREW, STEEL, NO. 10-32 X 1-1/2			344901047	1	100.00	01				
MACHINE SCREW, STEEL, NO. 10-32 X 2-3/4			344901052	1	400.00	01				
SELF TAPPING SCREW, NO. 6 X 1/4			345090602		200.00	01				
SELF TAPPING SCREW, NO. 8 X 1			345090810		500.00	01				
SELF TAPPING SCREW, NO. 10 X 3/4			345091008		200.00	01				
SELF TAPPING SCREW, NO. 10 X 7/8			345091009		1200.00	01				
NUT, STEEL, NO. 10-24			345951001		100.00	01				
LOCK WASHER, HELICAL SPRING, STEEL, NO.10			346207010		100.00	01				

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		3	1-18-65	1	1	X	YES	NO		P91138													
REV.		ISSUE DATE		SHEETS		SHEET		DRAWING		AMT. OF LOT		CENCO NUMBER		SUFFIX									
HYVAC 7 PUMP, SINGLE STAGE, UNMOUNTED												NAME OF ITEM		USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER			
PREPARED		PN/AG		CHECKED		P. M.		ENGINEER		APPROVED		E.C.N.		10534									
DESCRIPTION												(MADE FROM)		PART OR MATERIAL NUMBER		DASH NO.		QUANTITY PER C		UNITS		QUANTITY PER LOT	
DIRECTION PLATE														P25364				100.00		01			
PLASTIC CAP														P26077				100.00		01			
PLASTIC PIPE PLUG														P26108				100.00		01			
BLACK INSTRUMENT KNOB														P26139				100.00		01			
RUBBER GROMMET														P27120				100.00		01			
VANE SPRING														P28065				200.00		01			
CRESCENT TRUARC RING														P29260				300.00		01			
INTAKE SCREEN														P29296				100.00		01			
SHAFT KEY														P29313				200.00		01			
ALLOY STEEL CAP SCREW														P29316				500.00		01			
HOSE NIPPLE														P32168				100.00		01			
OIL LEVER														P35291				100.00		01			
SHAFT SEAL														P35332				100.00		01			
EXHAUST DOME														P35345				100.00		01			
HOUSING GASKET														P35394				200.00		01			
VANE														P60776				200.00		01			
ROTOR														P60777				100.00		01			
SEAL HOUSING														P60784				100.00		01			
VALVE LIMITER														P61018				100.00		01			
DRAIN HOUSING														P61284				100.00		01			
CENTER PLATE														P61285				100.00		01			
SHAFT														P61286				100.00		01			
END PLATE														P61376				100.00		01			
STATOR														P61377				100.00		01			
SPRING PIN														P63501				200.00		01			
FLUTTER VALVE														P65470				100.00		01			
EXHAUST BAFFLE														P65873				100.00		01			
VALVE ASSEMBLY														P67416				100.00		01			
THRUST WASHER														P78031				100.00		01			
THRUST WASHER														P78034				200.00		01			
1/4-20 X 3/4 STEEL CAP SCREW														344782508				1400.00		01			
1/4-20 X 1 3/4 STEEL CAP SCREW														344782514				200.00		01			
NO. 2 X 3/16 DRIVE SCREW														344800268				400.00		01			
10-24 X 1/4 STEEL MACHINE SCREW														344901002				200.00		01			
NO. 10 BRIGHT STEEL BURR														346200010				100.00		01			
STEEL WASHER, 1/4														346201025				500.00		01			
NO. 10 SPLITLOCK WASHER														346207010				100.00		01			

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		4	6-17-64	1	1	X	YES	NO		P91100													
REV.		ISSUE DATE		SHEETS		SHEET		DRAWING		AMT. OF LOT		CENCO NUMBER		SUFFIX									
HYVAC PUMP, UNMOUNTED												NAME OF ITEM		USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER			
PREPARED		JET/SB		CHECKED		JET		ENGINEER		APPROVED		E.C.N.		9747									
DESCRIPTION												(MADE FROM)		PART OR MATERIAL NUMBER		DASH NO.		QUANTITY PER C		UNITS		QUANTITY PER LOT	
ASSIGN SERIAL NUMBER IN P91100 SERIES																							
NAME PLATE														P25018				100.00		01			
PLASTIC CAP														P26184				100.00		01			
GASKET														P27136				100.00		01			
TENSION SPRING														P28002		1		200.00		01			
STEEL BALL														P29000		1		200.00		01			
LONG DOWEL PIN														P29172		1		200.00		01			
SHORT DOWEL PIN														P29173		1		600.00		01			
COVER GASKET														P35014				100.00		01			
PACKING														P35445				100.00		01			
MOUNTING PLATE														P60014		1		100.00		01			
EXHAUST RING														P60025		2		100.00		01			
HYVAC INTAKE VANE														P60027		1		100.00		01			
HYVAC ROTOR														P60031		1		200.00		01			
CENTER PLATE														P60032		1		100.00		01			
END PLATE														P60033		1		100.00		01			
HYVAC EXHAUST VANE														P60034		1		100.00		01			
HYVAC SHAFT														P60053		1		100.00		01			
INTAKE RING														P60063		1		100.00		01			
FINISHED PUMP CASE														P60118				100.00		01			
TRAP														P60764				100.00		01			
STEEL BUSHING														P63001		1		200.00		01			
KEY SPACER														P63010		1		100.00		01			
SPRING PIN														P63456		1		200.00		01			
BALL VALVE RETAINER														P65001		1		100.00		01			
OIL BAFFLE														P65003				100.00		01			
SMALL KEY														P65004		1		200.00		01			
SPRING LEVER ASSEMBLY														P67385				200.00		01			
EXHAUST DOME														P67389				100.00		01			
EXHAUST COVER														P67390				100.00		01			
INTAKE NIPPLE ASSEMBLY														P67400				100.00		01			
IRON PIPE PLUG														P69160				100.00		01			
PACKING NUT														P76000				100.00		01			
DRIVE SCREW, STEEL, NO. 0 X 1/8														344800067				400.00		01			
MACHINE SCREW, STEEL, NO. 10-32 X 3/4														344901042		1		200.00		01			
MACHINE SCREW, STEEL, NO. 8-32 X 5/16														344920803		1		200.00		01			
MACHINE SCREW, STEEL, NO. 10-32 X 1/2														344921040		1		100.00		01			
MACHINE SCREW, STEEL, NO. 10-32 X 1-1/2														344921047		1		100.00		01			
MACHINE SCREW, STEEL, NO. 10-32 X 3														344921053		1		400.00		01			
MACHINE SCREW, STEEL, NO. 10-32 X 1-5/8														344921063		1		500.00		01			
SELF TAPPING SCREW, NO. 6 X 1/4														345090602				200.00		01			
SELF TAPPING SCREW, NO. 8 X 3/8														345090804				400.00		01			
SELF TAPPING SCREW, NO. 10 X 3/4														345091008				200.00		01			
SELF TAPPING SCREW, NO. 10 X 7/8														345091009				200.00		01			
NUT, STEEL, NO. 10-24														345951001				200.00		01			
LOCK WASHER, HELICAL SPRING, STEEL, NO. 8														346207008		1		200.00		01			
LOCK WASHER, HELICAL SPRING, STEEL, NO. 10														346207010				200.00		01			

MATERIAL LIST
CENTRAL SCIENTIFIC COMPANY
A DIVISION OF CENCO INSTRUMENTS CORPORATION

3 1-18-65 1 1 X YES NO
REV. ISSUE DATE SHEETS SHEET DRAWING AMT. OF LOT CENCO NUMBER SUFFIX
P91142

MATERIAL LIST
CENTRAL SCIENTIFIC COMPANY
A DIVISION OF CENCO INSTRUMENTS CORPORATION

5 1-18-65 1 1 X YES NO
REV. ISSUE DATE SHEETS SHEET DRAWING AMT. OF LOT CENCO NUMBER SUFFIX
P91140

UNMOUNTED HYVAC 28 PUMP, SINGLE STAGE
NAME OF ITEM

USED ON/SERIAL NO. ORDER DATE SCHEDULE S. O. NUMBER

PREPARED PN/AG CHECKED P. W. ENGINEER APPROVED E.C.N. 10534

DESCRIPTION (MADE FROM) PART OR MATERIAL NUMBER DASH NO. QUANTITY PER C UNITS QUANTITY PER LOT

DIRECTION PLATE	P25370		100.00	01	
KNOB	P26139		100.00	01	
CAP, PLAIN	P26185		100.00	01	
PLUG, TAPERED	P26192		100.00	01	
GROMMET	P27120		100.00	01	
SPRING, VANE	P28064		200.00	01	
TRAUARC RING	P29187		300.00	01	
KEY, SHAFT	P29313		300.00	01	
CAP SCREW, ALLOY STEEL	P29317		1000.00	01	
INTAKE SCREEN	P29492		100.00	01	
PLUG, PIPE	P32002		100.00	01	
SHAFT SEAL	P35334		100.00	01	
GASKET, HOUSING	P35395		200.00	01	
EXHAUST DOME	P35617		100.00	01	
VANE	P60765		400.00	01	
ROTOR	P60766		200.00	01	
SEAL HOUSING	P60773		100.00	01	
VALVE LIMITER	P61018		200.00	01	
DRAIN HOUSING	P61118		100.00	01	
STATOR	P61351		200.00	01	
CENTER PLATE	P61352		100.00	01	
END PLATE	P61353		100.00	01	
END PLATE	P61354		100.00	01	
SHAFT	P61355		100.00	01	
SPRING PIN	P63499		200.00	01	
NIPPLE, HOSE 1 NPT	P63764		100.00	01	
FLUTTER VALVE	P65532		200.00	01	
VALVE ASSEMBLY	P67416		100.00	01	
WASHER, THRUST	P78032		100.00	01	
WASHER, THRUST	P78033		200.00	01	
CAP SCREW, STEEL, 5/16-18 X 1 INCH	344783110		1400.00	01	
CAP SCREW, STEEL, 5/16-18 X 2 INCH	344783115		400.00	01	
DRIVE SCREW, NO. 2 X 3/16	344800268		400.00	01	
MACHINE SCREW, STEEL, 10-24 X 1/4	344901002		400.00	01	
MACHINE SCREW, STEEL, NO. 10-32 X 7/16	344941005		400.00	01	
BURR, BRIGHT STEEL NO. 10	346200010		200.00	01	
STEEL WASHER, 5/16	346201031		1000.00	01	
WASHER, SPLITLOCK NO. 10	346207010		200.00	01	

VACUUM PUMP
NAME OF ITEM

USED ON/SERIAL NO. ORDER DATE SCHEDULE S. O. NUMBER

PREPARED PN/AG CHECKED P. W. ENGINEER APPROVED E.C.N. 10534

DESCRIPTION (MADE FROM) PART OR MATERIAL NUMBER DASH NO. QUANTITY PER C UNITS QUANTITY PER LOT

LATE, DIRECTION	P25357		100.00	01	
KNOB	P26139		100.00	01	
CAP	P26185		100.00	01	
GROMMET	P27120		100.00	01	
SPRING, VANE	P28064		100.00	01	
ING, TRUARC	P29187		300.00	01	
KEY, SHAFT	P29313		200.00	01	
CAP SCREW, STEEL ALLOY	P29317		500.00	01	
SCREEN, INTAKE	P29492		100.00	01	
IL LEVEL	P35291		100.00	01	
SEAL, SHAFT	P35334		100.00	01	
DOME, EXHAUST	P35341		100.00	01	
GASKET, HOUSING	P35395		200.00	01	
VANE	P60765		200.00	01	
OTOR	P60766		100.00	01	
HOUSING, SEAL	P60773		100.00	01	
LIMITER, VALVE	P61018		100.00	01	
LATE, CENTER	P61221		100.00	01	
HOUSING, DRAIN	P61222		100.00	01	
SHAFT	P61223		100.00	01	
STATOR	P61351		100.00	01	
END PLATE	P61353		100.00	01	
IN	P63499		100.00	01	
NIPPLE, HOSE	P63764		100.00	01	
VALVE, FLUTTER	P65532		100.00	01	
EXHAUST BAFFLE	P65767		100.00	01	
VALVE ASSEMBLY	P67416		100.00	01	
WASHER, THRUST	P78032		100.00	01	
WASHER, THRUST	P78033		200.00	01	
CAP SCREW, STEEL 5/16-18 X 1	344783110		1400.00	01	
CAP SCREW, STEEL 5/16-18 X 2	344783115		200.00	01	
DRIVE SCREW, STEEL NO. 2 X 3/16	344800268		400.00	01	
MACHINE SCREW, STEEL NO. 10-24 X 1/4	344901002		200.00	01	
BURR, STEEL NO. 10	346200010		100.00	01	
STEEL WASHER, 5/16	346201031		500.00	01	
WASHER, SPLITLOCK, STEEL NO. 10	346207010		100.00	01	

HYVAC 2 PUMP, UNMOUNTED
NAME OF ITEM

USED ON/SERIAL NO.

ORDER DATE

SCHEDULE

S. O. NUMBER

PREPARED PN/AG

CHECKED *Pn*

ENGINEER

APPROVED

E.C.N.

10534

DESCRIPTION

(MADE FROM)

PART OR MATERIAL NUMBER

DASH NO.

QUANTITY PER C

UNITS

QUANTITY PER LOT

ASSIGN SERIAL NUMBERS

DIRECTION PLATE
PLASTIC CAP
KNOB
RUBBER GROMMET
VANE SPRING

P25328
P26093
P26139
P27120
P28066

100.00 01
100.00 01
100.00 01
100.00 01
200.00 01

CRESCENT TRUARC RING
INTAKE SCREEN
SHAFT KEY
STEEL CAP SCREW
SHAFT SEAL

P29260
P29295
P29313
P29315
P35332

300.00 01
100.00 01
300.00 01
1000.00 01
100.00 01

EXHAUST DOME
HOUSING GASKET
VANE
ROTOR
EXHAUST STATOR

P35352
P35393
P60787
P60788
P60790

100.00 01
200.00 01
400.00 01
200.00 01
100.00 01

INTAKE END PLATE
INTAKE STATOR
CENTER PLATE
DRAIN HOUSING
SHAFT

P60791
P60792
P60793
P60794
P60797

100.00 01
100.00 01
100.00 01
100.00 01
100.00 01

VALVE LIMITER
SEAL HOUSING
EXHAUST END PLATE
SPRING PIN
FLUTTER VALVE

P60827
P61093
P61094
P63503
P65471

100.00 01
100.00 01
100.00 01
200.00 01
100.00 01

VALVE ASSEMBLY
HOSE NIPPLE
THRUST WASHER
THRUST WASHER
1/4-20 X 3/4 STEEL CAP SCREW

P67416
P69263
P78031
P78034
344782508

100.00 01
100.00 01
100.00 01
200.00 01
1000.00 01

1/4-20 X 1 STEEL CAP SCREW
2 X 3/16 STEEL DRIVE SCREW
10-24 X 1/4 STEEL MACHINE SCREW
NO. 10 STEEL BURR
STEEL WASHER, 1/4
NO. 10 SPLITLOCK WASHER

344782510
344800268
344901002
346200010
346201025
346207010

400.00 01
400.00 01
200.00 01
100.00 01
1000.00 01
100.00 01

HYVAC 2 PUMP, UNMOUNTED
NAME OF ITEM

USED ON/SERIAL NO.

ORDER DATE

SCHEDULE

S. O. NUMBER

PREPARED PN/AG

CHECKED *Pn*

ENGINEER

APPROVED

E.C.N.

10534

DESCRIPTION

(MADE FROM)

PART OR MATERIAL NUMBER

DASH NO.

QUANTITY PER C

UNITS

QUANTITY PER LOT

ASSIGN SERIAL NUMBERS

DIRECTION PLATE
PLASTIC CAP
VANE SPRING
INTAKE SCREEN
CRESCENT TRUARC RING

P25220
P26093
P28066
P29295
P29260

100.00 01
100.00 01
200.00 01
100.00 01
300.00 01

SHAFT KEY
STEEL CAP SCREW
OIL LEVEL
SHAFT SEAL
EXHAUST DOME

P29313
P29315
P35291
P35332
P35352

300.00 01
1000.00 01
100.00 01
100.00 01
100.00 01

HOUSING GASKET
INTAKE VANE
INTAKE ROTOR
EXHAUST END PLATE
EXHAUST STATOR
INTAKE END PLATE

P35393
P60787
P60788
P60789
P60790
P60791

200.00 01
400.00 01
200.00 01
100.00 01
100.00 01
100.00 01

INTAKE STATOR
CENTER PLATE
DRAIN HOUSING
SEAL HOUSING
SHAFT

P60792
P60793
P60894
P60795
P60797

100.00 01
100.00 01
100.00 01
100.00 01
100.00 01

VALVE LIMITER
SPRING PIN
FLUTTER VALVE
HOSE NIPPLE
THRUST WASHER

P60827
P63503
P65471
P69263
P78031

100.00 01
200.00 01
100.00 01
100.00 01
100.00 01

THRUST WASHER
1/4-20 X 3/4 STEEL CAP SCREW
1/4-20 X 1 STEEL CAP SCREW
2 X 3/16 STEEL DRIVE SCREW
10-24 X 1/4 STEEL MACHINE SCREW

P78034
344782508
344782510
344800268
344901002

200.00 01
1000.00 01
400.00 01
400.00 01
200.00 01

NO. 10 STEEL BURR
STEEL WASHER, 1/4
NO. 10 SPLITLOCK WASHER

346200010
346201025
346207010

100.00 01
1000.00 01
100.00 01

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		21	1-18-65	1	1	X	YES	NO		P91700					
REV.		ISSUE DATE		SHEETS		SHEET		DRAWING		AMT. OF LOT		CENCO NUMBER		SUFFIX	
UNMOUNTED HYVAC 14 PUMP				NAME OF ITEM		USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER			
PREPARED		PN/AG		CHECKED		P. M.		ENGINEER		APPROVED		E.C.N.		10534	
DESCRIPTION		(MADE FROM)		PART OR MATERIAL NUMBER		DASH NO.		QUANTITY PER C		UNITS		QUANTITY PER LOT			
O-RING				094236-005				33.33		91					
DIRECTION PLATE				P25212				100.00		01					
TAPERED CAPPLUG				P26129				100.00		01					
BLACK INSTRUMENT KNOB				P26139				100.00		01					
RUBBER GROMMET				P27120				100.00		01					
VANE SPRING				P28064				200.00		01					
TRUARC RING				P29187				300.00		01					
INTAKE SCREEN				P29297				100.00		01					
SHAFT KEY				P29313				300.00		01					
ALLOY STEEL CAP SCREW				P29317				1000.00		01					
STEEL BALL				P29514				100.00		01					
SHAFT SEAL				P35334				100.00		01					
EXHAUST DOME				P35341				100.00		01					
HOUSING GASKET				P35395				200.00		01					
VANE				P60765				400.00		01					
ROTOR				P60766				200.00		01					
EXHAUST END PLATE				P60767				100.00		01					
EXHAUST STATOR				P60768				100.00		01					
INTAKE END PLATE				P60769				100.00		01					
INTAKE STATOR				P60770				100.00		01					
CENTER PLATE				P60771				100.00		01					
DRAIN HOUSING				P60772				100.00		01					
SEAL HOUSING				P60773				100.00		01					
SHAFT				P60775				100.00		01					
VALVE LIMITER				P61018				100.00		01					
VALVE BLOCK				P61108				100.00		01					
SPRING PIN				P63499				200.00		01					
1 INCH VACUUM COUPLING NUT				P63519				100.00		01					
NIPPLE ADAPTER				P63546				100.00		01					
1 INCH HOSE NIPPLE				P63558				100.00		01					
FLUTTER VALVE				P65532				100.00		01					
EXHAUST BAFFLE				P65767				100.00		01					
VALVE ASSEMBLY				P67416				100.00		01					
THRUST WASHER				P78032				200.00		01					
THRUST WASHER				P78033				200.00		01					
5/16-18 X 1 STEEL CAP SCREW				344783110				1400.00		01					
5/16-18 X 2 STEEL CAP SCREW				344783115				400.00		01					
NO. 2 X 3/16 DRIVE SCREW				344800268				400.00		01					
10-24 X 1/4 STEEL MACHINE SCREW				344901002				200.00		01					
10-32 X 7/16 STEEL MACHINE SCREW				344941005				200.00		01					
NO. 10 BRIGHT STEEL BURR				346200010				100.00		01					
STEEL WASHER, 5/16				346201031				1000.00		01					
NO. 10 SPLITLOCK WASHER				346207010				100.00		01					

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		15	1-18-65	1	1	X	YES	NO		P91502					
REV.		ISSUE DATE		SHEETS		SHEET		DRAWING		AMT. OF LOT		CENCO NUMBER		SUFFIX	
HYVAC 7 GAS BALLAST PUMP, UNMOUNTED				NAME OF ITEM		USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER			
PREPARED		PN/AG		CHECKED		P. M.		ENGINEER		APPROVED		E.C.N.		10534	
DESCRIPTION		(MADE FROM)		PART OR MATERIAL NUMBER		DASH NO.		QUANTITY PER C		UNITS		QUANTITY PER LOT			
ASSIGN SERIAL NUMBERS															
O-RING				094236-004				33.33		91					
PIPE PLUG				P26108				100.00		01					
TAPERED PLUG				P26111				100.00		01					
INSTRUMENT KNOB				P26139				100.00		01					
RUBBER GROMMET				P27120				100.00		01					
VANE SPRING				P28065				200.00		01					
STEEL BALL				P29012				100.00		01					
CRESCENT TRUARC RING				P29260				300.00		01					
INTAKE SCREEN				P29296				100.00		01					
SHAFT KEY				P29313				300.00		01					
STEEL CAP SCREW				P29316				1000.00		01					
OIL LEVEL				P35291				100.00		01					
SHAFT SEAL				P35332				100.00		01					
EXHAUST DOME				P35345				100.00		01					
HOUSING GASKET				P35394				200.00		01					
VANE				P60776				400.00		01					
ROTOR				P60777				200.00		01					
EXHAUST END PLATE				P60778				100.00		01					
EXHAUST STATOR				P60779				100.00		01					
INTAKE END PLATE				P60780				100.00		01					
INTAKE STATOR				P60781				100.00		01					
CENTER PLATE				P60782				100.00		01					
DRAIN HOUSING				P60783				100.00		01					
SEAL HOUSING				P60784				100.00		01					
SHAFT				P60786				100.00		01					
VALVE LIMITER				P61018				100.00		01					
VALVE LIMITER				P61108				100.00		01					
SPRING PIN				P63501				200.00		01					
VACUUM COUPLING NUT				P63516				100.00		01					
NIPPLE ADAPTER				P63545				100.00		01					
HOSE NIPPLE				P63556				100.00		01					
FLUTTER VALVE				P65470				100.00		01					
VALVE ASSEMBLY				P67416				100.00		01					
THRUST WASHER				P78031				100.00		01					
THRUST WASHER				P78034				200.00		01					
CAP SCREW, STEEL, 1/4-20 X 3/4				344782508				1400.00		01					
CAP SCREW, STEEL, 1/4-20 X 1-3/4				344782514				400.00		01					
MACHINE SCREW, STEEL, 10-24 X 1/4				344901002				200.00		01					
MACHINE SCREW, STEEL, 10-32 X 7/16				344941005				200.00		01					
STEEL BURR, NO. 10				346200010				100.00		01					
STEEL WASHER, 1/4				346201025				1000.00		01					
SPLITLOCK WASHER, NO. 10				346207010				100.00		01					

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		5	1-18-65	1	1	X	YES DRAWING	NO DRAWING	AMT. OF LOT	CENCO NUMBER	SUFFIX
UNMOUNTED HYVAC 45 PUMP				USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER	
PREPARED	PN/AG	CHECKED	ENGINEER	APPROVED		E.C.N.		10534			
DESCRIPTION			(MADE FROM)		PART OR MATERIAL NUMBER		DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LOT	
DIRECTION PLATE					P25348			100.00	01		
BLACK INSTRUMENT KNOB					P26139			100.00	01		
PLASTIC PLUG					P26192			100.00	01		
CAP NIPPLE					P26209			100.00	01		
RUBBER GROMMET					P27120			100.00	01		
VANE SPRING					P28064			400.00	01		
TRUARC RING					P29187			300.00	01		
SHAFT KEY					P29313			500.00	01		
STEEL CAP SCREW, 5/16-18 X 6-1/2					P29458			500.00	01		
INTAKE SCREEN					P29513			100.00	01		
STEEL BALL					P29514			300.00	01		
CAP SCREW, STEEL, 5/16-18 X 6-1/4					P29553			500.00	01		
SHAFT SEAL					P35334			100.00	01		
HOUSING GASKET					P35395			200.00	01		
EXHAUST DOME					P35617			100.00	01		
VANE					P60765			800.00	01		
ROTOR					P60766			400.00	01		
EXHAUST END PLATE					P60767			100.00	01		
EXHAUST STATOR					P60768			100.00	01		
INTAKE END PLATE					P60769			100.00	01		
INTAKE STATOR					P60770			200.00	01		
VALVE LIMITER					P61018			100.00	01		
VALVE LIMITER					P61108			300.00	01		
DRAIN HOUSING					P61118			100.00	01		
SHAFT					P61144			100.00	01		
EXH SIDE INTERMEDIATE PLATE NO. 1					P61148			100.00	01		
EXH SIDE INTERMEDIATE PLATE NO. 2					P61149			100.00	01		
SEAL HOUSING					P61150			100.00	01		
CENTER PLATE					P61151			100.00	01		
EXHAUST SIDE INTAKE STATOR					P61152			100.00	01		
INTERMEDIATE PLATE					P61153			100.00	01		
SPRING PIN					P63499			400.00	01		
NIPPLE HOSE 1-1/2 INCH NPT					P63765			100.00	01		
FLUTTER VALVE					P65532			100.00	01		
VALVE ASSEMBLY					P67416			100.00	01		
THRUST WASHER					P78032			100.00	01		
THRUST WASHER					P78033			200.00	01		
CAP SCREW, STEEL, 5/16-18 X 1					344783110			1400.00	01		
CAP SCREW, STEEL, 5/16-18 X 2					344783115			800.00	01		
DRIVE SCREW, NO. 2 X 3/16					344800268			400.00	01		
MACHINE SCREW, STEEL, 10-24 X 1/4					344901002			200.00	01		
MACHINE SCREW, STEEL, 10-32 X 7/16					344941005			600.00	01		
BRIGHT STEEL BURR, NO. 10					346200010			100.00	01		
STEEL WASHER, 5/16					346201031			1000.00	01		
SPLITLOCK WASHER, NO. 10					346207010			100.00	01		

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION			9	1-18-65	1	1	X	YES DRAWING	NO	AMT. OF LOT	P91900	SUFFIX
REV.			ISSUE DATE			SHEETS		SHEET		CENCO NUMBER		
UNMOUNTED HYVAC 28 PUMP						USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER
NAME OF ITEM			ENGINEER			APPROVED			E.C.N. 10534			
PREPARED	PN/AG	CHECKED P.H.	(MADE FROM)			PART OR MATERIAL NUMBER		DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LOT	
DIRECTION PLATE						P25329			100.00	01		
BLACK INSTRUMENT KNOB						P26139			100.00	01		
CAP NIPPLE						P26185			100.00	01		
TAPERED PLUG						P26192			100.00	01		
RUBBER GROMMET						P27120			100.00	01		
WANE SPRING						P28064			300.00	01		
TRUARC RING						P29187			300.00	01		
SHAFT KEY						P29313			400.00	01		
ALLOY STEEL CAP SCREW						P29317			500.00	01		
INTAKE SCREEN						P29492			100.00	01		
STEEL BALL						P29514			200.00	01		
CAP SCREW, STEEL ALLOY, 5/16-18 X 6-1/4						P29553			500.00	01		
IRON PIPE PLUG						P32002			100.00	01		
SHAFT SEAL						P35334			100.00	01		
HOUSING GASKET						P35395			200.00	01		
EXHAUST DOME						P35617			100.00	01		
WANE						P60765			600.00	01		
MOTOR						P60766			300.00	01		
EXHAUST END PLATE						P60767			100.00	01		
EXHAUST STATOR						P60768			100.00	01		
INTAKE END PLATE						P60769			100.00	01		
INTAKE STATOR						P60770			200.00	01		
SEAL HOUSING						P60773			100.00	01		
VALVE LIMITER						P61018			100.00	01		
VALVE LIMITER						P61108			200.00	01		
DRAIN HOUSING						P61118			100.00	01		
SHAFT						P61129			100.00	01		
ENTER PLATE						P61131			100.00	01		
INTERMEDIATE PLATE						P61153			100.00	01		
SPRING PIN						P63499			300.00	01		
RIPPLE HOSE 1 INCH NPT						P63764			100.00	01		
FLUTTER VALVE						P65532			100.00	01		
VALVE ASSEMBLY						P67416			100.00	01		
THRUST WASHER						P78032			100.00	01		
THRUST WASHER						P78033			200.00	01		
CAP SCREW, STEEL, 5/16-18 X 1						344783110			1400.00	01		
CAP SCREW, STEEL, 5/16-18 X 2						344783115			400.00	01		
DRIVE SCREW, NO. 2 X 3/16						344800268			400.00	01		
MACHINE SCREW, STEEL, 10-24 X 1/4						344901002			200.00	01		
MACHINE SCREW, STEEL, 10-32 X 7/16						344941005			400.00	01		
RIGHT STEEL BURR, NO. 10						346200010			100.00	01		
STEEL WASHER, 5/16						346201031			1000.00	01		
SPRITLOCK WASHER, NO. 10						346207010			100.00	01		

MATERIAL LIST
CENTRAL SCIENTIFIC COMPANY
A DIVISION OF CENCO INSTRUMENTS CORPORATION

1 10-22-64 2 2 X NO
REV. ISSUE DATE SHEETS SHEET DRAWING AMT. OF LOT CENCO NUMBER SUFFIX

P91957

MATERIAL LIST
CENTRAL SCIENTIFIC COMPANY
A DIVISION OF CENCO INSTRUMENTS CORPORATION

1 10-22-64 2 1 X NO
REV. ISSUE DATE SHEETS SHEET DRAWING AMT. OF LOT CENCO NUMBER SUFFIX

P91957

HYVAC 150 PUMP						HYVAC 150 PUMP								
NAME OF ITEM		USED ON/SERIAL NO.	ORDER DATE	SCHEDULE	S. O. NUMBER	NAME OF ITEM		USED ON/SERIAL NO.	ORDER DATE	SCHEDULE	S. O. NUMBER			
PREPARED	HS/CH	CHECKED	ENGINEER	APPROVED	E.C.N.	PREPARED	HS/CH	CHECKED	ENGINEER	APPROVED	E.C.N.			
DESCRIPTION		(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS	DESCRIPTION		(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LOT
MACHINE SCREW, 6-32 X 1/4			344900602		400.00	01	EXHAUST FILTER DOME			093126-004		100.00	01	
MACHINE SCREW, 10-32 X 3/8			344951038		400.00	01	MALE ELBOW			P16141		100.00	01	
HEXAGON NUT, STEEL, 1/4-20			345952503		400.00	01	DIRECTION PLATE			P25363		100.00	01	
WASHER, NO. 10			346201010		400.00	01	KNOB			P26081		100.00	01	
SPLITLOCK WASHER, 1/4 IN.			346207025		400.00	01	SPRING			P28105		400.00	01	
SPLITLOCK WASHER, 5/16 IN.			346207031		800.00	01	SPRING			P28106		400.00	01	
SPLITLOCK WASHER, 1/2 IN.			346207050		1200.00	01	ROLL PINE			P29283		400.00	01	
							TRUARC RING			P29532		300.00	01	
							SHAFT SEAL			P29538		100.00	01	
							CAP SCREW, STEEL, 1/2-13 X 6-1/2			P29545		600.00	01	
							GASKET			P35846		200.00	01	
							SHAFT			P61238		100.00	01	
							MAIN BODY			P61242		100.00	01	
							EXHAUST STATOR			P61245		100.00	01	
							ROTOR, 3-1/2 IN.			P61247		100.00	01	
							ROTOR, 7 IN.			P61248		100.00	01	
							VANE, 3-1/2 IN.			P61249		200.00	01	
							VANE, 7 IN.			P61250		200.00	01	
							EXHAUST END CAP			P61251		100.00	01	
							INTAKE END CAP			P61252		100.00	01	
							FLAPPER			P61253		200.00	01	
							EXHAUST VALVE HOUSING			P61256		100.00	01	
							EXHAUST VALVE			P61257		100.00	01	
							HOUSING			P61261		100.00	01	
							SHAFT KEY, 1/4 IN. SQUARE			P61262		400.00	01	
							SHAFT KEY, 5/16 IN. SQUARE			P61263		100.00	01	
							VALVE STUD			P63779		400.00	01	
							VANE PIN			P63780		400.00	01	
							TUBE			P63781		100.00	01	
							DISK			P65646		100.00	01	
							VALVE BRACKET			P65862		200.00	01	
							THRUST WASHER			P65863		200.00	01	
							EXHAUST VALVE STOP			P65864		100.00	01	
							FLUTTER VALVE			P65865		200.00	01	
							VALVE ASSEMBLY			P67738		100.00	01	
							HOUSING ASSEMBLY			P67739		100.00	01	
							EXHAUST CENTER PLATE ASSEMBLY			P67740		100.00	01	
							END PLATE ASSEMBLY			P67741		200.00	01	
							WASHER			P78037		1200.00	01	
							CAP SCREW, 5/16-18 X 1-1/4			344753112		800.00	01	
							CAP SCREW, 1/2-13 X 2			344755015		600.00	01	
							CAP SCREW, 1/4-20 X 1-1/4			344782512		2400.00	01	
							CAP SCREW, 3/8-16 X 1-1/4			344783712		400.00	01	
							CAP SCREW, 3/8-16 X 2-1/4			344783716		200.00	01	
							DRIVE SCREW, NO. 2 X 3/16			344800268		400.00	01	

MATERIAL LIST
CENTRAL SCIENTIFIC COMPANY
A DIVISION OF CENCO INSTRUMENTS CORPORATION

1 10-22-64 2 2 X
REV. ISSUE DATE SHEETS SHEET YES NO
AMT. OF LOT CENCO NUMBER SUFFIX
P91959

MATERIAL LIST
CENTRAL SCIENTIFIC COMPANY
A DIVISION OF CENCO INSTRUMENTS CORPORATION

1 10-22-64 2 1 X
REV. ISSUE DATE SHEETS SHEET YES NO
AMT. OF LOT CENCO NUMBER SUFFIX
P91959

HYVAC 225 PUMP					HYVAC 225 PUMP				
NAME OF ITEM					NAME OF ITEM				
USED ON/SERIAL NO.					USED ON/SERIAL NO.				
ORDER DATE					ORDER DATE				
SCHEDULE					SCHEDULE				
S. O. NUMBER					S. O. NUMBER				
PREPARED HS/AG					PREPARED HS/AG				
CHECKED <i>d</i>					CHECKED <i>d</i>				
ENGINEER					ENGINEER				
APPROVED					APPROVED				
E.C.N.					E.C.N.				
DESCRIPTION					DESCRIPTION				
(MADE FROM)					(MADE FROM)				
PART OR MATERIAL NUMBER					PART OR MATERIAL NUMBER				
DASH NO.					DASH NO.				
QUANTITY PER C					QUANTITY PER C				
UNITS					UNITS				
QUANTITY PER LOT					QUANTITY PER LOT				
DRIVE SCREW, NO. 2 X 3/16					EXHAUST FILTER DOME				
MACHINE SCREW, 6-32 X 1/4					MALE ELBOW				
MACHINE SCREW, 10-32 X 3/8					DIRECTION PLATE				
HEXAGON NUT, STEEL, 1/4-20					KNOB				
WASHER, NO. 10					VANE SPRING				
SPLITLOCK WASHER, 1/4					VALVE SPRING				
SPLITLOCK WASHER, 5/16					ROLL PIN				
SPLITLOCK WASHER, 1/2					TRUARC RING				
					SHAFT SEAL				
					CAP SCREW, 1/2-13 X 6-1/2				
					GASKET				
					SHAFT				
					MAIN BODY				
					INTAKE STATOR, 3-1/2 IN.				
					EXHAUST STATOR				
					ROTOR, 3-1/2 IN.				
					ROTOR, 7 IN.				
					VANE, 3-1/2 IN.				
					VANE, 7 IN.				
					EXHAUST END CAP				
					INTAKE END CAP				
					VALVE				
					EXHAUST VALVE HOUSING				
					EXHAUST VALVE				
					HOUSING				
					SHAFT KEY, 1/4 IN. SQUARE				
					SHAFT KEY, 5/16 IN. SQUARE				
					VALVE STUD				
					VANE PIN				
					TUBE				
					DISK				
					VALVE BRACKET				
					THRUST WASHER				
					EXHAUST VALVE STOP				
					FLUTTER VALVE				
					VALVE ASSEMBLY				
					EXHAUST CENTER PLATE ASSEMBLY				
					END PLATE ASSEMBLY				
					INTAKE CENTER PLATE ASSEMBLY				
					HOUSING ASSEMBLY				
					WASHER				
					CAP SCREW, 5/16-18 X 1-1/4				
					CAP SCREW, 1/4-20 X 1-1/4				
					CAP SCREW, 3/8-16 X 1-1/4				
					CAP SCREW, 3/8-16 X 2-1/4				

HYVAC 225 PUMP					HYVAC 225 PUMP				
NAME OF ITEM					NAME OF ITEM				
USED ON/SERIAL NO.					USED ON/SERIAL NO.				
ORDER DATE					ORDER DATE				
SCHEDULE					SCHEDULE				
S. O. NUMBER					S. O. NUMBER				
PREPARED HS/AG					PREPARED HS/AG				
CHECKED <i>d</i>					CHECKED <i>d</i>				
ENGINEER					ENGINEER				
APPROVED					APPROVED				
E.C.N.					E.C.N.				
DESCRIPTION					DESCRIPTION				
(MADE FROM)					(MADE FROM)				
PART OR MATERIAL NUMBER					PART OR MATERIAL NUMBER				
DASH NO.					DASH NO.				
QUANTITY PER C					QUANTITY PER C				
UNITS					UNITS				
QUANTITY PER LOT					QUANTITY PER LOT				
					093126-004				
					P16141				
					P25365				
					P26081				
					P28105				
					P28106				
					P29283				
					P29532				
					P29538				
					P29545				
					P35846				
					P61239				
					P61242				
					P61243				
					P61245				
					P61247				
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					P61249				
					P61250				
					P61251				
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					P61256				
					P61257				
					P61261				
					P61262				
					P61263				
					P63779				
					P63780				
					P63781				
					P65646				
					P65862				
					P65863				
					P65864				
					P65865				
					P67738				
					P67740				
					P67741				
					P67742				
					P67748				
					P78037				
					344753112				
					344782512				
					344783712				
					344783716				

UNMID MEGAVAC PUMP

NAME OF ITEM USED ON/SERIAL NO. ORDER DATE SCHEDULE S. O. NUMBER
PREPARED WJH/AM CHECKED *WJH* ENGINEER APPROVED *WJH* E.C.N. 9564

DESCRIPTION	(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LOT
SERIAL NUMBERS		P25185		100.00	01	
DIRECTION NAME PLATE		P26077		100.00	01	
PLASTIC CAP		P27187		100.00	01	
MEGAVAC TRAP GASKET		P28070	1	100.00	01	
TENSION SPRING						
STEEL BALL		P29008	1	200.00	01	
LONG DOWEL PIN		P29174		200.00	01	
SHORT DOWEL PIN		P29175	1	600.00	01	
TRUARC RING		P29187		200.00	01	
STRIPPER BOLT		P29288	1	200.00	01	
HOSE NIPPLE		P32168		100.00	01	
EXHAUST COVER GASKET		P35020		100.00	01	
SEAL ASSEMBLY		P35219		100.00	01	
EXHAUST DOME		P35345		100.00	01	
MEGAVAC PUMP ROTOR		P60003	1	200.00	01	
SIDE PLATE		P60006	1	100.00	01	
END PLATE		P60008	1	100.00	01	
MEGAVAC EXHAUST RING		P60009	1	100.00	01	
MEGAVAC INTAKE RING		P60010	2	100.00	01	
MEGAVAC EXHAUST VANE		P60026	1	100.00	01	
MEGAVAC INTAKE VANE		P60035	1	100.00	01	
FINISHED PUMP CASE		P60138		100.00	01	
MEGAVAC PUMP SHAFT		P60681	1	100.00	01	
THRUST BEARING		P60693	1	100.00	01	
FINISHED TRAP PLATE		P60705		100.00	01	
CENTER PLATE		P60829	1	100.00	01	
BUSHING		P63009	1	100.00	01	
RETAINING RING		P63446		100.00	01	
BALL VALVE RETAINING PLATE		P65002	1	100.00	01	
LARGE KEY		P65008	1	200.00	01	
EXHAUST COVER ASSEMBLY		P67383		100.00	01	
VANE LEVER		P67395	1	200.00	01	
PIPE PLUG		P69160		100.00	01	
CAP SCREW, STEEL, 5/16-18 X 3		344753119		600.00	01	
CAP SCREW, STEEL, 5/16-24 X 1		344753144		400.00	01	
CAP SCREW, STEEL, 5/16-24 X 2-1/4		344753150	1	100.00	01	
CAP SCREW, STEEL, 5/16-24 X 2-1/2		344753151	1	700.00	01	
CAP SCREW, STEEL, 5/16-24 X 3		344753153		600.00	01	
CAP SCREW, STEEL, 5/16-24 X 4-1/2		344753158		100.00	01	
DRIVE SCREW, NO. 2 X 3/16		344800268		400.00	01	
MACHINE SCREW, STEEL, 8-32 X 1		344900806		400.00	01	
MACHINE SCREW, STEEL, 10-32 X 3/8		344921038	1	200.00	01	
BRIGHT STEEL BURR, 5/16		346200031	1	100.00	01	
SPLITLOCK WASHER, NO. 10		346207010	1	200.00	01	
SPLITLOCK WASHER, 5/16		346207031	1	700.00	01	
SPLITLOCK WASHER, 5/16		346207031		1000.00	01	

HYVAC 300 PUMP

NAME OF ITEM USED ON/SERIAL NO. ORDER DATE SCHEDULE S. O. NUMBER
PREPARED HS/AG CHECKED *HS* ENGINEER APPROVED *HS* E.C.N.

DESCRIPTION	(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LOT
EXHAUST FILTER DOME		093126-004		100.00	01	
MALE ELBOW		P16141		100.00	01	
DIRECTION PLATE		P25366		100.00	01	
KNOB		P26081		100.00	01	
VANE SPRING		P28105		600.00	01	
VALVE SPRING		P28106		400.00	01	
ROLL PIN		P29283		400.00	01	
TRUARC RING		P29532		300.00	01	
SHAFT SEAL		P29538		100.00	01	
CAP SCREW, 1/2-13 X 6-1/2		P29545		600.00	01	
CAP SCREW, 1/2-13 X 10		P29547		600.00	01	
GASKET		P35846		200.00	01	
SHAFT		P61240		100.00	01	
MAIN BODY		P61242		100.00	01	
INTAKE STATOR, 7 IN.		P61244		100.00	01	
EXHAUST STATOR		P61245		100.00	01	
ROTOR, 3-1/2 IN.		P61247		100.00	01	
ROTOR, 7 IN.		P61248		200.00	01	
VANE, 3-1/2 IN.		P61249		200.00	01	
VANE, 7 IN.		P61250		400.00	01	
EXHAUST END CAP		P61251		100.00	01	
INTAKE END CAP		P61252		100.00	01	
VALVE		P61253		200.00	01	
EXHAUST VALVE HOUSING		P61256		100.00	01	
EXHAUST VALVE		P61257		100.00	01	
SHAFT SEAL HOUSING		P61261		100.00	01	
SHAFT KEY, 1/4 IN. SQUARE		P61262		600.00	01	
SHAFT KEY, 5/16 IN. SQUARE		P61263		100.00	01	
VALVE STUD		P63779		400.00	01	
VANE PIN		P63780		600.00	01	
TUBE		P63781		100.00	01	
DISK		P65646		100.00	01	
VALVE BRACKET		P65862		200.00	01	
THRUST WASHER		P65863		200.00	01	
EXHAUST VALVE STOP		P65864		100.00	01	
FLUTTER VALVE		P65865		200.00	01	
VALVE ASSEMBLY		P67738		100.00	01	
EXHAUST CENTER PLATE ASSEMBLY		P67740		100.00	01	
END PLATE ASSEMBLY		P67741		200.00	01	
INTAKE CENTER PLATE ASSEMBLY		P67742		100.00	01	
HOUSING ASSEMBLY		P67749		100.00	01	
WASHER		P78037		1200.00	01	
CAP SCREW, 5/16-18 X 1-1/4		344753112		800.00	01	
CAP SCREW, 1/4-20 X 1-1/4		344782512		2400.00	01	
CAP SCREW, 3/8-16 X 1-1/4		344783712		400.00	01	

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		8	10-22-64	2	2	X	YES	NO		P93006			
REV.		ISSUE DATE		SHEETS		SHEET		DRAWING		AMT. OF LOT		CENCO NUMBER	SUFFIX
HYPERVAC 23 PUMP, UNMOUNTED NAME OF ITEM				USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER			
PREPARED HS/AG		CHECKED d.		ENGINEER		APPROVED		E.C.N.					
DESCRIPTION		(MADE FROM)		PART OR MATERIAL NUMBER		DASH NO.		QUANTITY PER C		UNITS		QUANTITY PER LOT	
1/4-20 X 1 STEEL CAP SCREW				344752510				400.00		01			
5/16-18 X 1 STEEL CAP SCREW				344753110				400.00		01			
5/16-18 X 1-3/4 STEEL CAP SCREW				344753114				2200.00		01			
5/16-24 X 1 STEEL CAP SCREW				344753144				400.00		01			
1/2-13 X 1-1/4 STEEL CAP SCREW				344755012				400.00		01			
1/4-20 X 1-1/2 STEEL CAP SCREW				344782513				200.00		01			
5/16-18 X 1-1/4 STEEL CAP SCREW				344783112				400.00		01			
10-32 X 1/2 STEEL MACHINE SCREW				344901040				400.00		01			
8-32 X 1/2 STEEL MACHINE SCREW				344920806				400.00		01			
8-32 X 7/8 STEEL MACHINE SCREW				344920809				200.00		01			
10-32 X 1/4 STEEL MACHINE SCREW				344921036				100.00		01			
1/4-20 X 1/2 STEEL MACHINE SCREW				344922506				200.00		01			
1/4-20 X 3/4 STEEL MACHINE SCREW				344922508				600.00		01			
NO. 1214 SHAKEPROOF WASHER				346204014				600.00		01			
NO. 8 SPLITLOCK WASHER				346207008				800.00		01			
NO. 10 SPLITLOCK WASHER				346207010				400.00		01			
1/4 SPLITLOCK WASHER				346207025				1400.00		01			
5/16 SPLITLOCK WASHER				346207031				3100.00		01			
1/2 SPLITLOCK WASHER				346207050				400.00		01			

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		9	10-22-64	2	1	X	YES	NO		P93006			
REV.		ISSUE DATE		SHEETS		SHEET		DRAWING		AMT. OF LOT		CENCO NUMBER	SUFFIX
HYPERVAC 23 PUMP, UNMOUNTED NAME OF ITEM				USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER			
PREPARED HS/AG		CHECKED d.		ENGINEER		APPROVED		E.C.N.					
DESCRIPTION		(MADE FROM)		PART OR MATERIAL NUMBER		DASH NO.		QUANTITY PER C		UNITS		QUANTITY PER LOT	
ASSIGN SERIAL NUMBERS													
PLASTIC CAP				P26185				100.00		01			
PLASTIC PLUG				P26192				100.00		01			
FLANGE GASKET				P27066				100.00		01			
EXTENSION SPRING				P28000				200.00		01			
TAPER PIN				P29014				800.00		01			
TRUARC RING				P29229				100.00		01			
TRUARC RING				P29230				100.00		01			
PIPE PLUG				P32010				100.00		01			
ELBOW				P32012				100.00		01			
HEXAGON BUSHING				P32170				100.00		01			
OIL TRAP BOTTOM GASKET				P35017				100.00		01			
SEAL ASSEMBLY				P35256				100.00		01			
TRAP GASKET				P35258				100.00		01			
SCREEN SUPPORT GASKET				P35259				100.00		01			
EXHAUST DOME				P35617				100.00		01			
WOODRUFF KEY				P60041				100.00		01			
STEEL ROLLER				P60045				100.00		01			
VANE YOKE				P60047				100.00		01			
TRAP SCREEN				P60086				100.00		01			
RING				P60324				100.00		01			
TRAP				P60448				100.00		01			
ROLLER RETAINING BLOCK				P60670				100.00		01			
SEAL HOUSING GUIDE				P60678				100.00		01			
SEAL HOUSING				P60679				100.00		01			
SEAL HOUSING COVER				P60680				100.00		01			
SHAFT				P60685				100.00		01			
SPACER BLOCK				P60694				100.00		01			
FLANGE				P60702				100.00		01			
ROTOR				P60706				100.00		01			
LOWER SPACER BLOCK				P60709				100.00		01			
SCREEN SUPPORT ASSEMBLY				P60805				100.00		01			
END BEARING PLATE				P60806				100.00		01			
INTAKE TUBE				P63084				100.00		01			
HOSE NIPPLE				P63764				100.00		01			
EXHAUST DOME COVER				P65475				100.00		01			
PULLEY END PLATE				P67373				100.00		01			
REAR END PLATE				P67375				100.00		01			
VANE ASSEMBLY				P67377				100.00		01			
EXHAUST VALVE BLOCK ASSEMBLY				P67379				100.00		01			
DOME ASSEMBLY				P67380				100.00		01			
VANE SPRING SUPPORT ASSEMBLY				P67382				200.00		01			
LEAD WASHER				P78001				400.00		01			
LEAD WASHER				P78002				300.00		01			
1/16 DIA. X 1/2 STEEL COTTER PIN				344006205				200.00		01			
1/4-20 X 5/8 STEEL CAP SCREW				344752507				600.00		01			

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		6	10-22-64	3	2	X YES DRAWING	NO DRAWING	AMT. OF LOT	CENCO NUMBER	P93020	SUFFIX
HYPERVAC 25 PUMP, UNMOUNTED NAME OF ITEM		REV.	ISSUE DATE	SHEETS	SHEET						
PREPARED HS/AG		CHECKED d.	ENGINEER	APPROVED	E.C.N.			USED ON/SERIAL NO.	ORDER DATE	SCHEDULE	S. O. NUMBER
DESCRIPTION	(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS			QUANTITY PER LOT			
FLANGE		P60702		100.00	01						
BACKING PUMP CASE COVER		P60703		100.00	01						
BACKING PUMP MOUNTING PLATE		P60704	2	100.00	01						
ROTOR		P60706		100.00	01						
SCREEN SUPPORT ASSEMBLY		P60805		100.00	01						
INTAKE TUBE		P63084		100.00	01						
VALVE SPRING SCREW		P63452		200.00	00						
SPRING PIN		P63470		100.00	01						
HOSE NIPPLE		P63764		100.00	01						
KEY		P65004	2	100.00	01						
VALVE CAGE		P65005	2	100.00	01						
CHECK VALVE RETAINER		P65006	2	100.00	01						
CHECK VALVE		P65007	2	300.00	01						
GEAR ASSEMBLY		P67076	2	100.00	01						
VALVE BODY ASSEMBLY		P67368		100.00	01						
BACKING PUMP CASE ASSEMBLY		P67371		100.00	01						
BACKING PUMP END PLATE		P67372		100.00	01						
PULLEY END PLATE		P67373		100.00	01						
SPRING LEVER ASSEMBLY		P67374	2	100.00	01						
VANE SPRING SUPPORT ASSEMBLY		P67382		200.00	01						
SPACER BUSHING		P75506	2	100.00	01						
LEAD WASHER		P78001		400.00	01						
LEAD WASHER		P78002		100.00	01						
BRASS WASHER		P78700	2	100.00	01						
0.028 DIA. BRASS WIRE		122061021		0.20	32						
1/16 DIA. X 3/8 STEEL COTTER PIN		344006203	1	200.00	01						
1/16 DIA. X 1/2 STEEL COTTER PIN		344006205		200.00	01						
1/4-20 X 1 STEEL CAP SCREW		344752510		400.00	01						
5/16-18 X 1 STEEL CAP SCREW		344753110		400.00	01						
5/16-18 X 1-3/4 STEEL CAP SCREW		344753114		1100.00	01						
5/16-18 X 2-1/2 STEEL CAP SCREW		344753117		600.00	01						
5/16-24 X 1 STEEL CAP SCREW		344753144		400.00	01						
1/2-13 X 1-1/4 STEEL CAP SCREW		344755012		400.00	01						
5/16-18 X 1-1/4 STEEL CAP SCREW		344783112		400.00	01						
5/16-18 X 2 STEEL CAP SCREW		344783115		500.00	01						
NO. 2 X 3/16 DRIVE SCREW		344800268		400.00	01						
8-32 X 5/16 STEEL MACHINE SCREW		344900803	2	200.00	01						
8-32 X 1 STEEL MACHINE SCREW		344900810		500.00	01						
10-32 X 1/2 STEEL MACHINE SCREW		344901040		400.00	01						
10-32 X 1/2 STEEL MACHINE SCREW		344901040	2	100.00	01						
10-32 X 1-1/2 STEEL MACHINE SCREW		344901047	2	100.00	01						
8-32 X 1/2 STEEL MACHINE SCREW		344920806		400.00	01						
8-32 X 7/8 STEEL MACHINE SCREW		344920809		200.00	01						
10-32 X 1/4 STEEL MACHINE SCREW		344921036		100.00	01						
10-32 X 1/2 STEEL MACHINE SCREW		344921040		700.00	01						

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		24	10-22-64	3	1	X YES DRAWING	NO DRAWING	AMT. OF LOT	CENCO NUMBER	P93020	SUFFIX
HYPERVAC 25 PUMP, UNMOUNTED NAME OF ITEM		REV.	ISSUE DATE	SHEETS	SHEET						
PREPARED HS/AG		CHECKED d.	ENGINEER	APPROVED	E.C.N.			USED ON/SERIAL NO.	ORDER DATE	SCHEDULE	S. O. NUMBER
DESCRIPTION	(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS			QUANTITY PER LOT			
DIRECTION PLATE		P25177		100.00	01						
PLASTIC CAP		P26185		100.00	01						
PLASTIC PLUG		P26192		100.00	01						
FLANGE GASKET		P27066		100.00	01						
EXTENSION SPRING		P28000		200.00	01						
TENSION SPRING		P28005	2	100.00	01						
VALVE SPRING		P28060		200.00	01						
TAPER PIN		P29014		800.00	01						
DOWEL PIN		P29173	2	600.00	01						
ROLL PIN		P29318		100.00	01						
PIPE PLUG		P32010		100.00	01						
HEXAGON BUSHING		P32170		100.00	01						
PIPE PLUG		P32171		100.00	01						
COVER GASKET		P35014		100.00	01						
OIL TRAP BOTTOM GASKET		P35017		100.00	01						
SEAL ASSEMBLY		P35256		100.00	01						
TRAP GASKET		P35258		100.00	01						
SCREEN SUPPORT GASKET		P35259		100.00	01						
REAR SEAL ASSEMBLY		P35280		100.00	01						
BACKING PUMP CASE GASKET		P35281		100.00	01						
EXHAUST DOME		P35352		100.00	01						
EXHAUST DOME		P35617		100.00	01						
RING		P60015	2	100.00	01						
END PLATE		P60016	2	100.00	01						
ROTOR		P60017	2	100.00	01						
VANE		P60019	2	100.00	01						
WOODRUFF KEY		P60041		100.00	01						
STEEL ROLLER		P60045		100.00	01						
VANE YOKE		P60047		100.00	01						
TRAP SCREEN		P60086		100.00	01						
PRESSOVAC SHAFT		P60088	2	100.00	01						
RING		P60324		100.00	01						
TRAP		P60448		100.00	01						
VANE		P60628		100.00	01						
ROLLER RETAINING BLOCK		P60670		100.00	01						
SEAL HOUSING GUIDE		P60678		100.00	01						
SEAL HOUSING		P60679		100.00	01						
SEAL HOUSING COVER		P60680		100.00	01						
SPACER BLOCK		P60694		100.00	01						
SHAFT		P60695	1	100.00	01						
BACKING PUMP DRIVE GEAR		P60696	1	100.00	01						
GEAR RETAINING PIN		P60697	1	100.00	01						
DOME		P60698		100.00	01						
THRUST BRACKET		P60699		100.00	01						
RELIEF VALVE BLOCK		P60701		100.00	01						

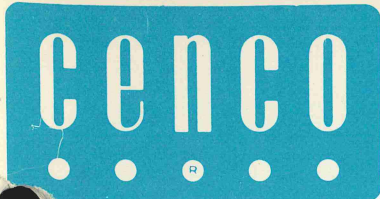
MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION			12 REV.	10-22-64 ISSUE DATE	3 SHEETS	1 SHEET	X YES NO DRAWING	AMT. OF LOT	P93033 CENCO NUMBER	SUFFIX
NAME OF ITEM			USED ON/SERIAL NO.		ORDER DATE		SCHEDULE		S. O. NUMBER	
PREPARED	CHECKED	ENGINEER	APPROVED		E.C.N.					
DESCRIPTION			(MADE FROM)	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LO		
ASSIGN SERIAL NUMBERS										
CORK, NO. 8				P06028		100.00	01			
STEEL CASTING, PATTERN NO. 2132				P16042		200.00	01			
CONNECTOR				P22160		100.00	01			
OIL LEVEL GLASS DISC				P25350		100.00	01			
DIRECTION PLATE				P28005		100.00	01			
TENSION SPRING				P28006		400.00	01			
STOP SPRING				P28007		200.00	01			
VANE SPRING				P28012		200.00	01			
COMPRESSION SPRING				P29011		200.00	01			
WOODRUFF KEY				P29146		100.00	01			
DOWEL PIN				P29173		600.00	01			
DOWEL PIN				P32000		100.00	01			
PIPE PLUG				P32001		300.00	01			
PIPE PLUG				P32002		100.00	01			
PIPE PLUG				P32003	3	100.00	01			
PIPE PLUG				P32004		100.00	01			
ELBOW				P32005		100.00	01			
ELBOW				P32006		100.00	01			
STEEL NIPPLE				P32142		100.00	01			
PUMP SEAL				P35241		100.00	01			
RING				P60015	8	100.00	01			
END PLATE				P60016		100.00	01			
ROTOR				P60017		100.00	01			
VANE				P60019		100.00	01			
OIL LEVEL FLANGE				P60048		100.00	01			
EXHAUST DOME				P60070		100.00	01			
EXHAUST DOME				P60071		100.00	01			
VANE SUPPORT				P60073		100.00	01			
ROLLER				P60074		100.00	01			
ROLLER STOP				P60076		100.00	01			
ROTOR				P60079		100.00	01			
SHAFT				P60080		100.00	01			
VANE				P60081		100.00	01			
SHAFT				P60088	11	100.00	01			
OUTSIDE COLLAR AND PIN				P60115	4	100.00	01			
COLLAR AND PIN				P60116		100.00	01			
VANE BAR				P60121		100.00	01			
HAND HOLE COVER				P60124		100.00	01			
DRIVING GEAR				P60127		100.00	01			
VANE BLOCK				P60657		200.00	01			
SIDE OPENING COVER				P60658		100.00	01			
RING				P60659		100.00	01			
BACKING PUMP END PLATE				P60660		100.00	01			
PULLEY END PLATE				P60661		100.00	01			

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION			13	10-22-64	3	3	X YES	NO DRAWING	AMT. OF LOT	P93020 CENCO NUMBER	SUFFIX
HYPERVAC 25 PUMP, UNMOUNTED NAME OF ITEM			USED ON/SERIAL NO.			ORDER DATE		SCHEDULE		S. O. NUMBER	
PREPARED	CHECKED	ENGINEER	APPROVED			E.C.N.					
DESCRIPTION	MADE FROM	PART OR MATERIAL NUMBER	DASH NO.	QUANTITY PER C	UNITS	QUANTITY PER LOT					
10-32 X 1-3/4 STEEL MACHINE SCREW		344921048		200.00	01						
10-32 X 2-3/4 STEEL MACHINE SCREW		344921052		400.00	01						
10-32 X 1-3/8 STEEL MACHINE SCREW		344921064		600.00	01						
1/4-20 X 1/2 STEEL MACHINE SCREW		344922506		200.00	01						
1/4-20 X 3/4 STEEL MACHINE SCREW		344922508		200.00	01						
1/4-20 X 3/4 STEEL MACHINE SCREW		344922508		600.00	01						
10-24 STEEL HEXAGON NUT		345951001		100.00	01						
1/4 STEEL BURR		346200025		400.00	01						
NO. 8 SPLITLOCK WASHER		346207008		800.00	01						
NO. 10 SPLITLOCK WASHER		346207010		1900.00	01						
1/4 SPLITLOCK WASHER		346207025		1200.00	01						
5/16 SPLITLOCK WASHER		346207031		3100.00	01						
1/2 SPLITLOCK WASHER		346207050		400.00	01						

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		10	1-21-65	3	2	X	NO		P93033			
REV.		ISSUE DATE		SHEETS		SHEET		DRAWING		AMT. OF LOT	CENCO NUMBER	SUFFIX
HYPERVAC 100 PUMP												
NAME OF ITEM												
USED ON/SERIAL NO.												
ORDER DATE												
SCHEDULE												
S. O. NUMBER												
PREPARED JD/CH												
CHECKED JD												
ENGINEER												
APPROVED												
E.C.N. 10586												
DESCRIPTION												
(MADE FROM)												
PART OR MATERIAL NUMBER												
DASH NO.												
QUANTITY PER C												
UNITS												
QUANTITY PER LOT												
SPLASH PLATE												
P60662												
100.00												
01												
VANE DOME												
P60663												
100.00												
01												
INTAKE DOME												
P60664												
100.00												
01												
SEAL HOUSING												
P60665												
100.00												
01												
INTAKE SCREEN												
P60666												
100.00												
01												
PUMP PULLEY KEY												
P60667												
100.00												
01												
FLOAT VALVE BODY												
P60668												
100.00												
01												
FLOAT VALVE PLUNGER												
P60669												
100.00												
01												
FLANGE												
P60719												
100.00												
01												
CHECK VALVE RETAINER												
P63006												
100.00												
01												
TAPER PIN ASSEMBLY												
P63032												
600.00												
01												
GEAR PIN												
P63097												
200.00												
01												
SPRING PIN												
P63470												
100.00												
01												
SMALL KEY												
P65004												
100.00												
01												
VALVE CAGE												
P65005												
100.00												
01												
CHECK VALVE												
P65007												
300.00												
01												
SEAL HOUSING GASKET												
P65416												
100.00												
01												
FLANGE GASKET												
P65442												
100.00												
01												
DRIVEN GEAR ASSEMBLY												
P67076												
100.00												
01												
CORK FLOAT												
P67078												
100.00												
01												
BYPASS VALVE ASSEMBLY												
P67358												
100.00												
01												
BACKING PUMP COVER												
P67359												
100.00												
01												
VANE SPRING SUPPORT												
P67360												
200.00												
01												
FLOAT VALVE SCREEN												
P67361												
100.00												
01												
SPRING LEVER ASSEMBLY												
P67386												
100.00												
01												
VANE DOME GASKET												
P69000												
100.00												
01												
OIL LEVEL GASKET												
P69001												
200.00												
01												
EXHAUST DOME GASKET												
P69002												
100.00												
01												
HAND HOLE COVER GASKET												
P69014												
100.00												
01												
INTAKE DOME GASKET												
P69119												
100.00												
01												
SIDE OPENING COVER GASKET												
P69120												
100.00												
01												
FLOAT VALVE BODY GASKET												
P69121												
100.00												
01												
ROLLER STOP SCREW												
P75504												
400.00												
01												
SPACER BUSHING												
P75506												
100.00												
01												
BY-PASS VALVE SCREW												
P75548												
200.00												
01												
STEEL WASHER												
P78026												
100.00												
01												
BRASS WASHER												
P78700												
100.00												
01												
1/4 O.D. X 0.032 WL COPPER TUBING												
161012515												
7.00												
32												
0.0625 DIA. STEEL ROD												
340089040												
1												
0.10												
32												
0.0625 DIA. STEEL ROD												
340089040												
2												
32												
0.065 X 24 X 96 STEEL SHEET												
343530310												
7												
15.00												
32												
1/8 IN. DIA. ROUND STEEL ROD												
360086010												
9												
0.50												
32												
1 IN. DIA. ROUND STEEL ROD												
360086100												
10												
6.00												
32												
MACHINE SCREW, BRASS, 4-40 NC X 3/8												
124910404												
600.00												
01												
NO. 10 BRASS WASHER												
126201010												
400.00												
01												
3/32 DIA. X 1/2 STEEL COTTER PIN												
344009305												
400.00												
01												

MATERIAL LIST CENTRAL SCIENTIFIC COMPANY A DIVISION OF CENCO INSTRUMENTS CORPORATION		14	1-28-65	3	3	X	NO		P93033			
REV.		ISSUE DATE		SHEETS		SHEET		DRAWING		AMT. OF LOT	CENCO NUMBER	SUFFIX
HYPERVAC 100 PUMP												
NAME OF ITEM												
USED ON/SERIAL NO.												
ORDER DATE												
SCHEDULE												
S. O. NUMBER												
PREPARED WH/AG												
CHECKED												
ENGINEER												
APPROVED												
E.C.N. 10637												
DESCRIPTION												
(MADE FROM)												
PART OR MATERIAL NUMBER												
DASH NO.												
QUANTITY PER C												
UNITS												
QUANTITY PER LOT												
3/16-24 X 7/8 STEEL CAP SCREW												
344753143												
300.00												
01												
3/8-11 X 2-1/4 STEEL CAP SCREW												
344756216												
400.00												
01												
1/4-20 X 5/8 STEEL CAP SCREW												
344782507												
800.00												
01												
1/4-20 X 3/4 STEEL CAP SCREW												
344782508												
600.00												
01												
1/4-20 X 1 STEEL CAP SCREW												
344782510												
600.00												
01												
1/4-20 X 1 STEEL CAP SCREW												
344782510												
600.00												
01												
5/16-18 X 7/8 STEEL CAP SCREW												
344783109												
400.00												
01												
3/16-18 X 1 STEEL CAP SCREW												
344783110												
3800.00												
01												
3/8-16 X 1-3/4 STEEL CAP SCREW												
344783714												
1400.00												
01												
3/8-26 X 2 STEEL CAP SCREW												
344783715												
3400.00												
01												
3/8-16 X 2-1/2 STEEL CAP SCREW												
344783717												
100.00												
01												
NO. 0 X 1/8 DRIVE SCREW												
344800067												
400.00												
01												
3-32 X 7/16 STEEL MACHINE SCREW												
344900605												
800.00												
01												
3-32 X 5/16 STEEL MACHINE SCREW												
344900803												
200.00												
01												
10-32 X 1/2 STEEL MACHINE SCREW												
344901040												
100.00												
01												
10-32 X 1-1/2 STEEL MACHINE SCREW												
344901047												
100.00												
01												
1/4-20 X 1/2 STEEL MACHINE SCREW												
344902506												
400.00												
01												
2-56 X 1/4 STEEL MACHINE SCREW												
344900202												
100.00												
01												
6-32 X 1-1/8 STEEL MACHINE SCREW												
344900611												
200.00												
01												
8-32 X 3/8 STEEL MACHINE SCREW												
344920804												
400.00												
01												
8-32 X 1/2 STEEL MACHINE SCREW												
344920806												
400.00												
01												
10-32 X 5/8 STEEL MACHINE SCREW												
344921041												
200.00												
01												
10-32 X 3/4 STEEL MACHINE SCREW												
344921042												
400.00												
01												
10-32 X 1-1/8 STEEL MACHINE SCREW												
344921045												
400.00												
01												
10-32 X 2-3/4 STEEL MACHINE SCREW												
344921052												
400.00												
01												
2-56 HEXAGON STEEL NUT												
345950200												
100.00												
01												
10-24 HEXAGON STEEL NUT												
345951001												
100.00												
01												
NO. 6 SPLITLOCK WASHER												
346207006												
200.00												
01												
NO. 8 SPLITLOCK WASHER												
346207008												
400.00												
01												
NO. 10 SPLITLOCK WASHER												
346207010												
100.00												
01												
NO. 10 SPLITLOCK WASHER												
346207010												
600.00												
01												
1/4 IN. SPLITLOCK WASHER												
346207025												
600.00												
01												
5/16 IN. SPLITLOCK WASHER												
346207031												
400.00												
01												
5/8 IN. SPLITLOCK WASHER												
346207062												
400.00												
01												

Central Scientific Co.
1700 IRVING PK. RD.
CHICAGO 13, ILLINOIS



W. IRVING PK. RD. CHICAGO 13, ILL.
CENTRAL SCIENTIFIC COMPANY

mechanical vacuum pumps

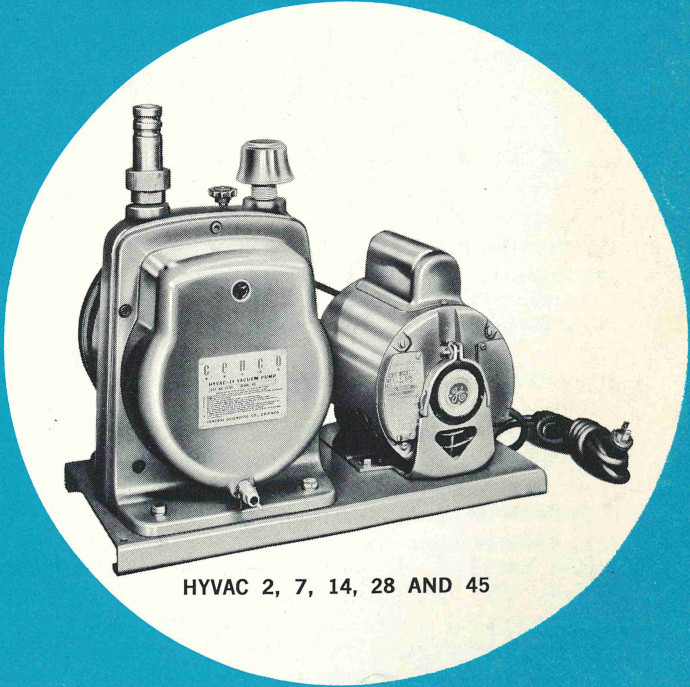
A COMPLETE LINE OF HIGH VACUUM PUMPS, GAGES, SYSTEMS, & COMPONENTS
MAKERS OF THE WORLD RENOWNED HYVAC® PUMPS

CENCO HYVAC PUMP



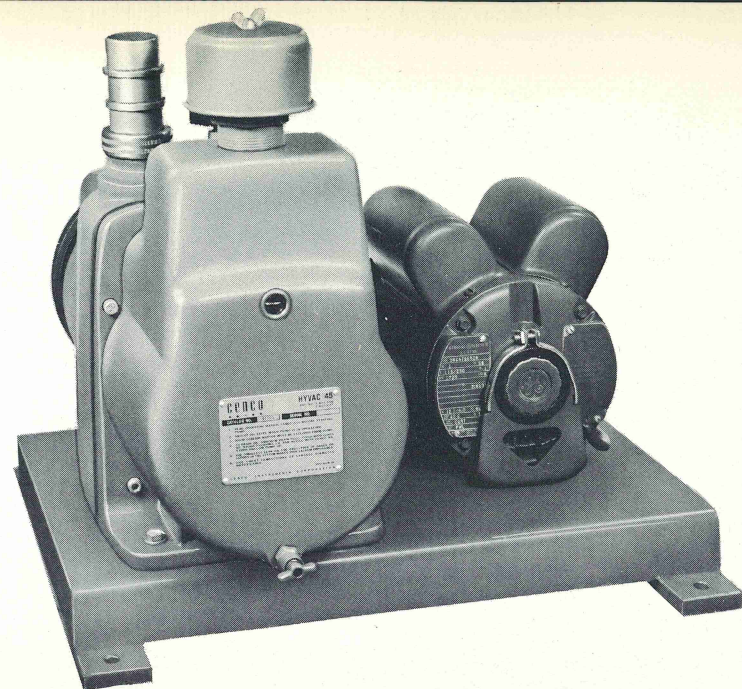
A two-stage, oil sealed mechanical pump of the internal moving vane design for pumping down to 0.1 microns of vacuum with high speed. Its reasonable cost and size make this dependable pump ideal for research and educational laboratory applications. It has also found wide acceptance in the chemical process industry where a continuous high vacuum is required. Available unmounted or mounted with motor, line cord and switch. Priced from \$151.00.

	GUARANTEED VACUUM <i>(microns of mercury)</i>	CAPACITY <i>at atmosphere at 1 micron</i> <i>(liters per min.) (liters per min.)</i>		BOOKLET
Hyvac	0.3	10	5	320
Hyvac 2	0.1	25	13	321
Hyvac 7	0.1	79	35	
Hyvac 14	0.1	140	75	
Hyvac 28	0.05	280	150	
Hyvac 45	0.05	450	280	
Megavac	0.1	57	22	323
Hypervac 23	5.0	240	—	324
Hypervac 25	0.1	264	120	
Hypervac 100	0.1	960	660	
Provac	15.0	35	—	325
Blower Pump	3 IN. Hg	35	—	326



HYVAC 2, 7, 14, 28 AND 45

THE HYVAC 45



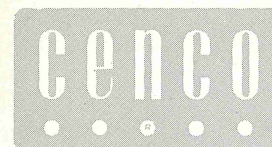
A NEW ADDITION TO THE CENCO HYVAC FAMILY

The Hyvac 45 is the latest and largest addition to Cenco's line of Hyvac high vacuum pumps. Designed around the same fine internal vane principle as the other pumps in the Hyvac series, the Hyvac 45 combines high speed and lower ultimate vacuum — with very little increase in size or weight.

This series-connected, two-stage pump produces a guaranteed vacuum of 0.05 microns of Hg with a pumping speed of 450 liters per minute at atmospheric pressure (280 liters per minute at 1 micron). Available unmounted or mounted with a choice of motors.

All prices F.O.B. our nearest branch as of publication date. Applicable taxes will be added. Exact current prices available on request. Terms: 30 days net.

We have attempted to describe accurately the merchandise listed in this bulletin. Additional information will be gladly given upon request. The company warrants that each item of merchandise sold by it is free from defective workmanship or material upon return of the same to the company office at Chicago, Illinois. This warranty is made in lieu of all other warranties, express or implied, and no other warranty, express or implied, is assumed or will be assumed.



Central Scientific Co.

a division of Cenco Instruments Corporation
1700 IRVING PARK ROAD, CHICAGO 13, ILL.



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TWX-WSFD-NJ 262

SOMERVILLE, MASSACHUSETTS

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PRospect 6-1800
TWX-SMVL-MASS 583

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FAirfax 4-2433
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RAYmond 3-6141
TWX-MTB 3815

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1 description

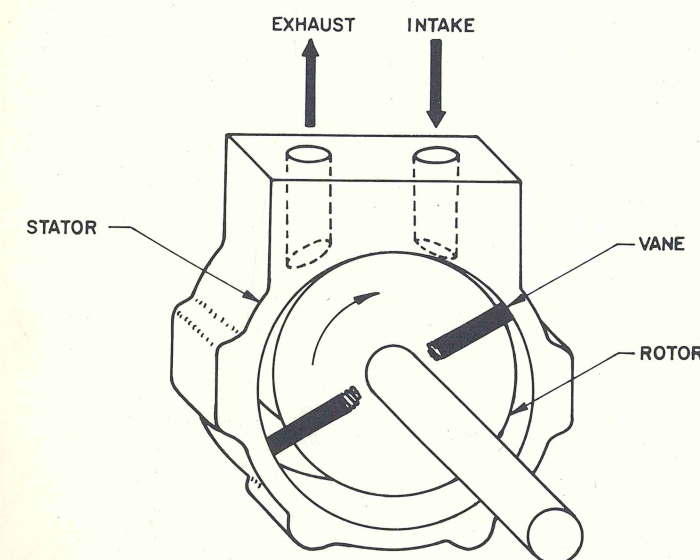


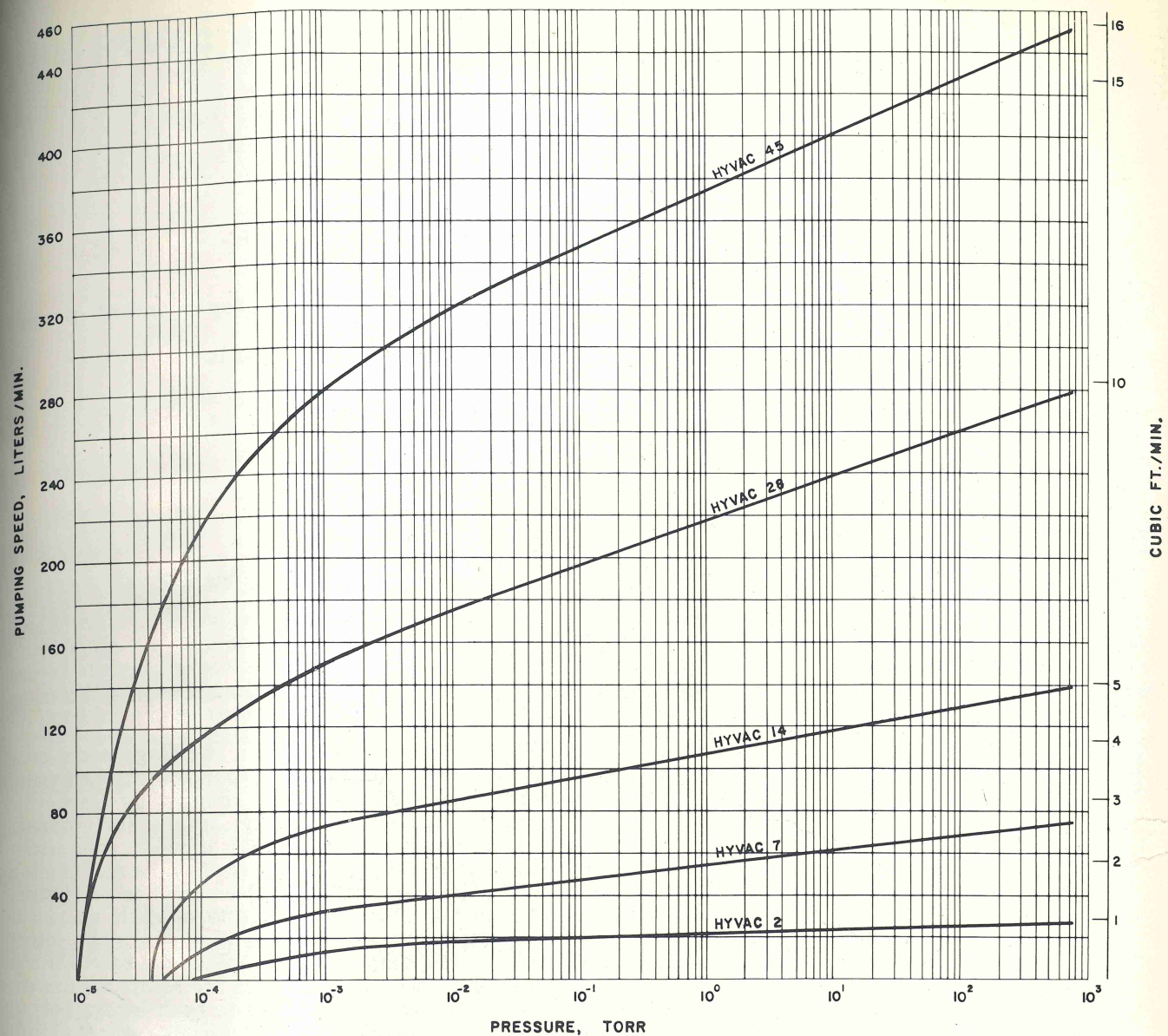
Fig. 1 Operating Principle, Internal Vane Type Vacuum Pump

1.1 general

Combining quiet, vibrationless operation, high speed and efficiency with low ultimate pressure, the Cenco Hyvac Vacuum Pump is used in general purpose, high-vacuum applications. It is especially recommended for use as an economical roughing pump, and as a backing pump for diffusion pumps.

The Cenco Hyvac Pump is a two-stage, series-connected, mechanical vacuum pump utilizing the internal vane principal, first adopted by Gaede for vacuum use. The two stages, intake and exhaust, consist of cylindrical chambers in which concentrically driven rotors are offset so they contact the top of the chambers throughout a complete revolution. The intake and exhaust ports of each stage are placed on either side of the area where the rotors contact the chambers. Two vanes are fitted in the slots of each rotor so that, as the rotors are driven, the small volume connected to each intake port is expanded, cut off, and the gaseous contents compressed into the exhaust ports.

Lubricating oil for the exhaust stage enters through the bearing and oil holes in the exhaust endplate. Oil flow to the intake stage is controlled by the centerplate bearing and degassed by the exhaust stage before it is allowed to reach the intake stage. The intake nipple and exhaust dome are connected to the centerplate of the pump. The centerplate contains a large intake volume so that oil will not "back up" into the system if the pump is stopped and left connected to the system under vacuum for a long period of time. The intake and exhaust stages are supported by the centerplate. Around the stages, and bolted to the centerplate, are the two housings. The housings contain the drain cock, oil level sight gage, oil shaft seal, mounting holes for supporting the pump, and oil bath, in which both stages are submerged. Bathing both stages in oil serves a threefold purpose: (1) insuring a vacuum-tight seal of the stages, (2) acting as a coolant, and (3) lubricating the moving parts through the oiling holes. Since the Hyvac Vacuum Pump contains precision machined parts, a high quality, specially compounded oil should be used. Cenco Hyvac Oil No. 93050, provided with the pump, is specially processed and should always be used to obtain maximum performance.



PUMPING SPEED VS. PRESSURE CURVE
FOR CENCO HYVAC PUMPS

1.2 pump data

The speed pressure characteristics of the Cenco Hyvac Pump are shown in Fig. 1. Additional pump data are as follows:

	Hyvac 2	Hyvac 7	Hyvac 14	Hyvac 28	Hyvac 45
Pump speed (rpm)	580	525	525	525	550
Capacity at atmospheric pressure (liter/min.)	25	79	140	280	450
Capacity at 1 micron of mercury (liter/min.)	13	35	75	150	280
Guaranteed vacuum (microns of mercury)	0.1	0.1	0.1	0.05	0.05
Merit Factor, (%) ¹	52	44	54	54	62
Gas Ballast	optional	yes	yes	yes	yes

¹ The merit factor is the ratio of the pumping speed at one micron to the pumping speed at atmospheric pressure.

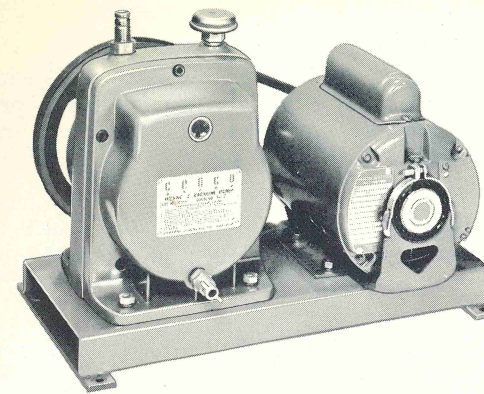
1.3 unmounted pump

Cenco Hyvac pumps are available unmounted. Four mounting holes are provided and a grooved pulley is supplied with each pump.

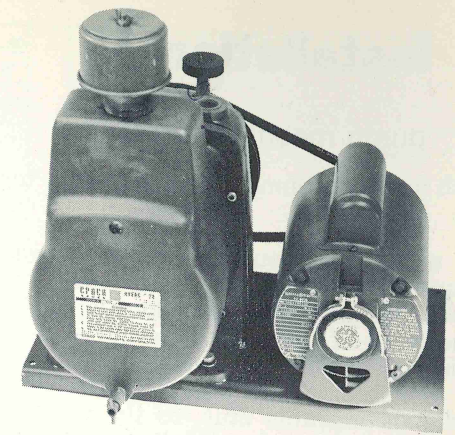
CENCO NO.	MODEL	GAS BALLAST
91300	Hyvac 2	No
91306	Hyvac 2	Yes
91502	Hyvac 7	Yes
91700	Hyvac 14	Yes
91900	Hyvac 28	Yes
91950	Hyvac 45	Yes

1.4 pump mounted with motor

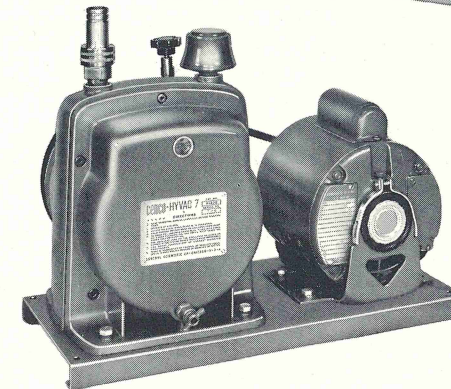
The Hyvac Pumps, Cenco Nos. 91305, 91308, 91506, 91705, 91905, and 91955 are assembled on steel bases and are supplied with motors and belt drives.



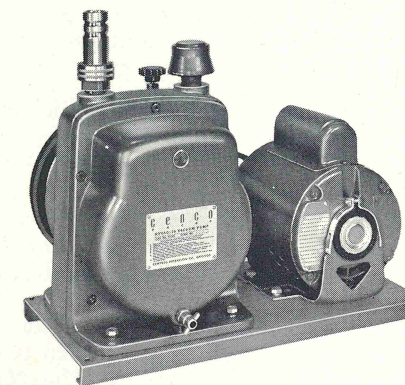
No. 91305 Hyvac 2
No. 91308 Hyvac 2



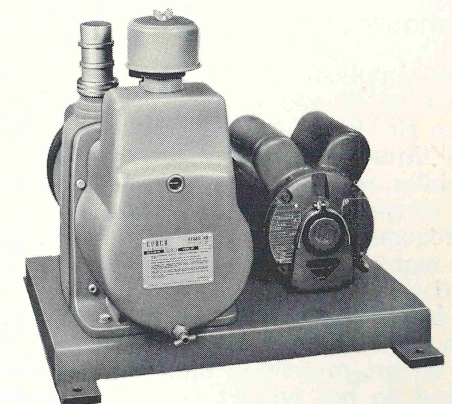
No. 91905 Hyvac 28



No. 91506 Hyvac 7



No. 91705 Hyvac 14



No. 91955 Hyvac 45

Without Gas Ballast	With Gas Ballast					MOTOR RATING	
HYVAC 2 Cenco No.	HYVAC 2 Cenco No.	HYVAC 7 Cenco No.	HYVAC 14 Cenco No.	HYVAC 28 Cenco No.	HYVAC 45 Cenco No.	Voltage, Volts	Type Cycles
91305-1	91308-1	91506-1	91705-1	91905-1	91955-1	115/230	60
91305-7	91308-7	91506-7	91705-7	91905-7	91955-7	115/230	50
91305-10*	91308-10*	91506-10*	91705-10*	91905-10*	91955-10*	115/230 115	60 60
91305-18	91308-18	91506-18	91705-18	91905-18	91955-18	220/440	50/60
91305-23	91308-23	91506-23	91705-23	91905-23	91955-23	no motor supplied	

* Explosion-Proof

PUMP MODEL	HYVAC 2	HYVAC 7	HYVAC 14	HYVAC 28	HYVAC 45
Motor Horsepower, hp	0.25	0.33	0.50	1.00	1.00

2 installation

2.1 pump mounting

Each mounted pump is shipped ready for immediate use.

An unmounted pump, however, first should be mounted on a flat, rigid, steel or cast-iron base, such as that supplied with the mounted unit. The major dimensions of the pump, pump base and motor are given in Fig. 2. Provisions should be made for bolting the base to the floor or, if the pump is to be used in a movable unit, to the frame. When electronic equipment is attached to the same frame, shock mounts should be installed so that vibrations from the motor or pump will not be transmitted through the frame. A belt drive connects the motor to the pump. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump. The best operating speed is 580 rpm for the Hyvac 2, 525 rpm for the Hyvac 7, 14 and 28, and 550 rpm for the Hyvac 45. A variation in speed of 50 rpm will only change the volumetric speed of the pump. *A pump should be mounted perfectly level so the oil level can be read accurately.*

2.2 motor connection

Motors supplied with the Hyvac 2 (Cenco Nos. 91305-1 to -7 and 91308-1 to -7) and Hyvac 7 (Cenco No. 91506-1 to -7) have a connecting cord and a three-prong plug attached. All other pump assemblies require permanent connections. In all cases, connect the motor to a powerline of the voltage, frequency and phase indicated on the nameplate of the motor. The powerline should be heavy enough to carry the current required without any undue drop in voltage. All motors can be operated on across-the-line start. Remember that fuses provide short circuit protection only for the power supply line and do not protect the motor from overload. A suitable starting switch with motor overload protection should be used for all permanent installations. For correct selection of the fuse, consult the table below:

Pump Model	Cenco Pump No.	Current at Full Load (Amperes)			Max. Fuse Rating (Amperes)		
		at 115V	at 230V	at 440V	at 115V	at 230V	at 440V
Hvac 2	91305-1	4.4	2.2	..	15	15	15
	91305-7	4.8	2.4	..	..	..	..
	91305-10	4.4	2.2	..	..	..	..
	91305-18	..	1.1	0.6	..	..	..
Hvac 7	91506-1	5.6	2.8	..	20	15	15
	91506-7	6.2	3.1	..	25	..	..
	91506-10	5.6	2.8	..	20	..	..
	91506-18	..	1.6	0.8	..	..	..
Hvac 14	91705-1	7.8	3.9	..	25	15	15
	91705-7	7.4	3.7	..	..	..	..
	91705-10	7.8	3.9	..	..	..	..
	91705-18	..	1.9	0.9	..	..	..
Hvac 28	91905-1	13	6.5	..	30	15	15
	91905-7	12	6.0	..	..	..	..
	91905-10	13	6.5	..	..	..	..
	91905-18	..	3.6	1.8	..	..	..
Hvac 45	91955-1	13	6.5	..	30	15	15
	91955-7	12	6.0	..	..	..	..
	91955-10	13	6.5	..	..	..	..
	91955-18	..	3.6	1.8	..	..	..

2.3 vacuum connections

The Hyvac 2, 28, and 45 pumps are provided with one-piece intake nipples which are intended primarily for use with rubber tubing. The Hyvac 7 and 14 are provided with a vacuum coupling as illustrated in Fig. 4 and Fig. 5.

It is recommended that the following procedure be observed before making any vacuum connections:

- (1) Remove the plastic protector from the hose nipple (or vacuum coupling).
- (2) Remove the plug from the exhaust port, and install the exhaust dome.
- (3) Remove the drain plug and install the drain cock.

When making glass connections between the pump intake nipple and the vacuum system, use a short rubber hose as a coupling between nipple and glass tube.

When tapered glass joints or ball joints are used in connections, a vacuum stopcock grease (No. 15517-1 or No. 15522) should be applied to both members. Rubber tubing connections should be made with an extra heavy wall, gum tubing, such as No. 18204, which has been compounded specially for vacuum work. All connections to metal or glass tubing should fit snugly, and both members should be coated with vacuum stopcock grease.

If metal piping is used, it is best to solder or braze all connections. If threaded pipe joints are used, the threads should be as perfect as possible. When making threaded connection, screw the members together several turns, and then apply Glyptal to the exposed threads before screwing them together tightly. Allow the Glyptal to dry several hours before starting the pump. If flanged connections are used, install flat or "O"-ring gaskets, made of rubber or Neoprene, between the flanges to eliminate leakage. Place a thin coat of oil on the "O" ring before using. Cenco manufactures an extensive line of couplings, connections and accessories for use in high vacuum systems (See Cenco Booklet 327). Some of these accessories are:

Cenco No.	Type of Coupling	Type of Connection	Size Range, inches
94226	straight through	glass and/or metal	$\frac{3}{8}$ to 1
94235	straight through	metal and/or rubber	$\frac{1}{4}$ to 1
94228	reducing	glass and/or metal	$\frac{3}{8}$ to 1
94230	connectors	metal-to-glass	$\frac{3}{8}$ to 1
94240	caps	for 94235	$\frac{1}{4}$ to 2
94245	nipples	rubber	$\frac{3}{8}$ to 1 $\frac{1}{2}$

When connecting the pump to the system to be evacuated, take extreme care to eliminate leakage. All connections should be as short as possible and of large diameter to reduce molecular friction. When the pump is operating in the low micron range, the flow of gas through a tube is substantially molecular in character. At low pressures, the gas removed from the system is confined largely to those molecules which, because of their kinetic energy, happen to

ITEM	NO. 91305 HYVAC 2	NO. 91505 HYVAC 7	NO. 91705 HYVAC 14	NO. 91305	NO. 91505	NO. 91705
A	10 $\frac{5}{16}$	12 $\frac{5}{16}$	15 $\frac{11}{16}$	T	10 $\frac{1}{8}$	13 $\frac{5}{8}$
B	9 $\frac{15}{16}$	11 $\frac{5}{16}$	12 $\frac{11}{16}$	U	3 $\frac{7}{8}$	7 $\frac{7}{16}$
C	4 $\frac{15}{16}$	5 $\frac{5}{8}$	5 $\frac{15}{16}$	V	1 $\frac{15}{16}$	1 $\frac{15}{16}$
D	5 $\frac{1}{2}$	6 $\frac{1}{4}$	6 $\frac{13}{16}$	W	—	3 $\frac{1}{2}$
E	7	8 $\frac{1}{4}$	9 $\frac{5}{8}$	Y	7 $\frac{7}{16}$	7 $\frac{1}{2}$
F	6	7 $\frac{1}{4}$	8 $\frac{5}{8}$			
G	2 $\frac{1}{16}$	2 $\frac{1}{8}$	2			
H	4 $\frac{3}{4}$	6	7			
I	1 $\frac{1}{2}$	1 $\frac{1}{8}$	1 $\frac{1}{8}$			
J	1 $\frac{1}{8}$	1 $\frac{1}{8}$	1 $\frac{1}{8}$			
K	15	17 $\frac{1}{4}$	17 $\frac{7}{8}$			
L	14 $\frac{1}{4}$	16 $\frac{1}{2}$	17 $\frac{1}{8}$			
M	4 $\frac{1}{2}$	5 $\frac{3}{4}$	6			
N	3 $\frac{13}{16}$	4 $\frac{9}{16}$	4 $\frac{7}{8}$			
P	7 $\frac{13}{16}$	8 $\frac{13}{16}$	9 $\frac{1}{16}$			
Q	3 $\frac{3}{8}$	3 $\frac{3}{8}$	3 $\frac{3}{8}$			
R	3 $\frac{3}{8}$	4 $\frac{5}{16}$	4 $\frac{3}{8}$			
S	7 $\frac{7}{8}$	7 $\frac{7}{8}$	7 $\frac{7}{8}$			
X	6 $\frac{9}{16}$	8 $\frac{1}{16}$	8 $\frac{11}{16}$			

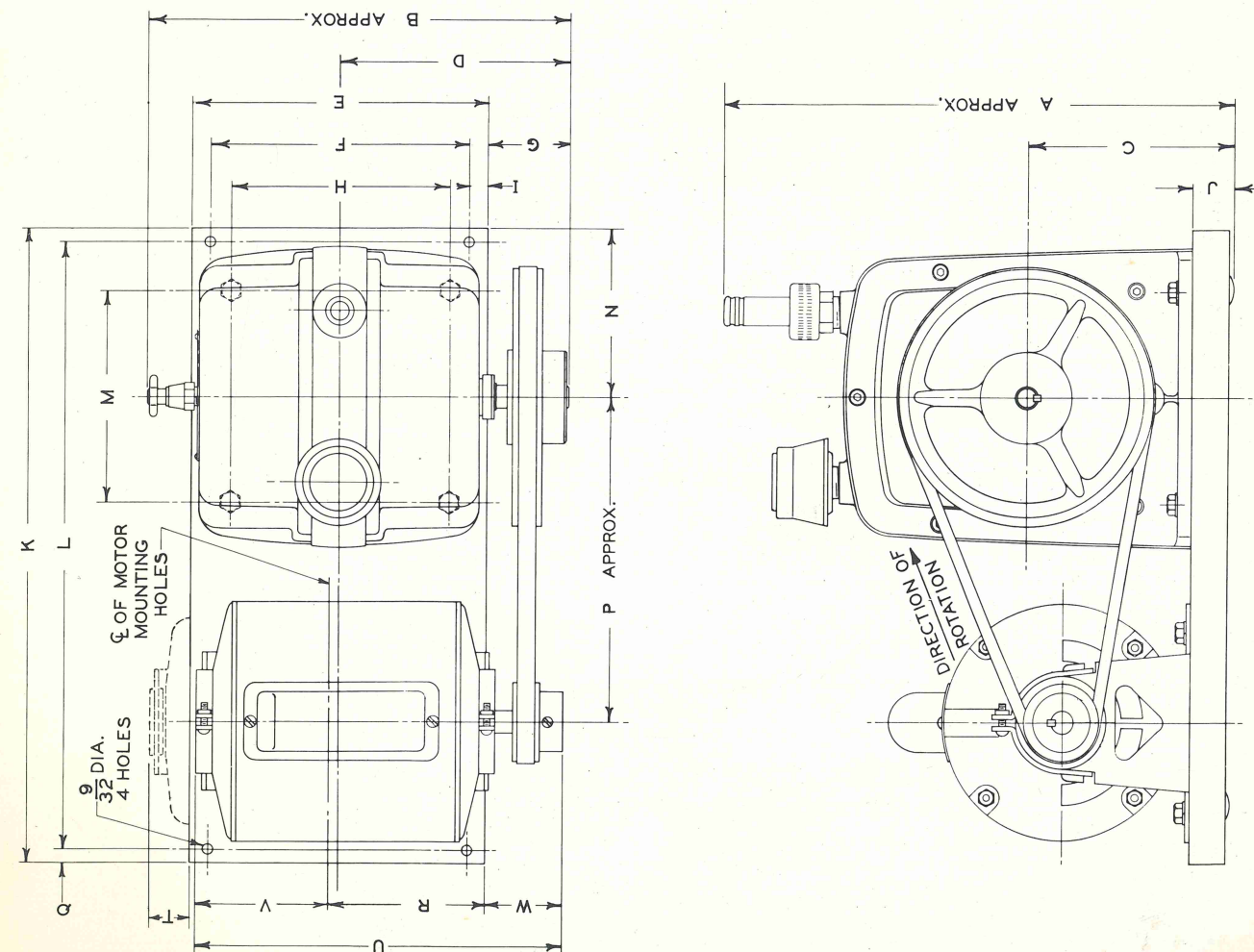
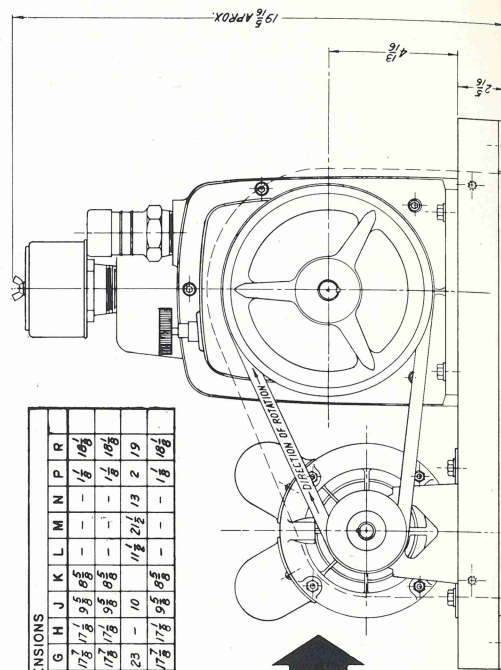
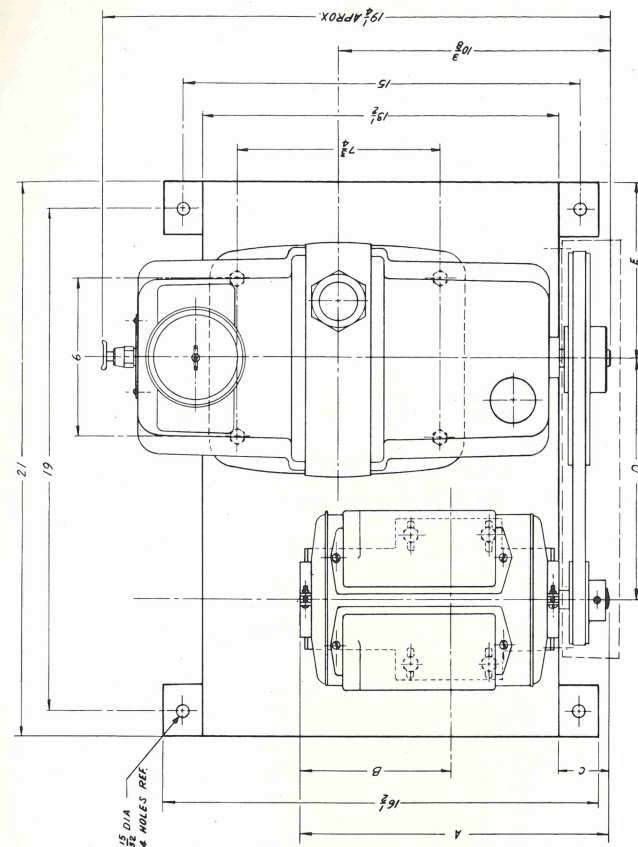
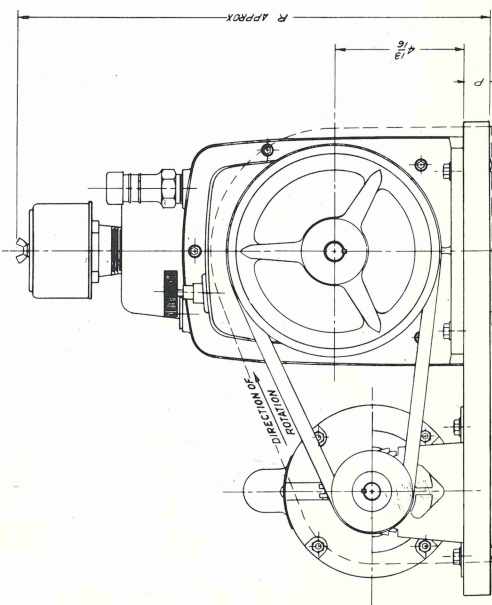
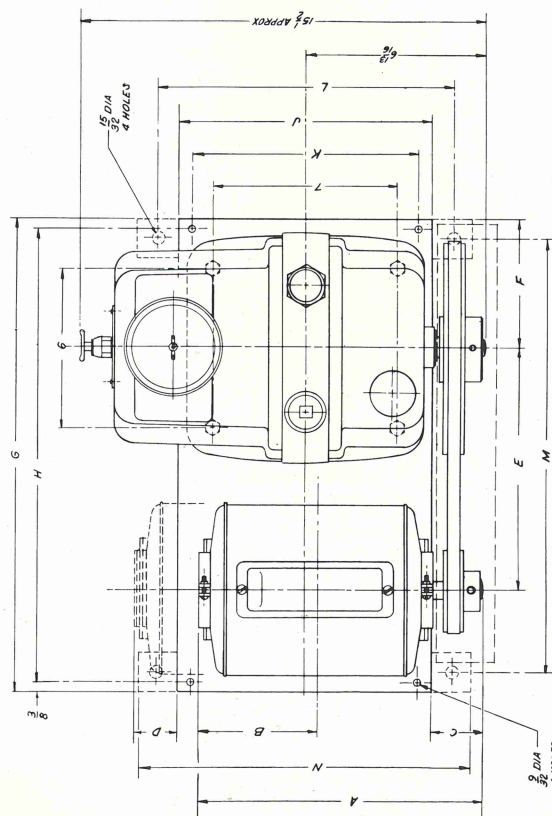


Fig. 2. Hyvac 2, 7, and 14



CATALOG NO.	DIMENSIONS															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	
91905-1	1 1/2	5 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
91905-7	1 1/2	6 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
91905-10	1 1/2	6 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
91905-18	1 1/2	6 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2

CATALOG NO.	DIMENSIONS				
	A	B	C	D	E
91955-1	1 1/2	5 1/2	1 1/2	1 1/2	1 1/2
91955-7	1 1/2	6 1/2	1 1/2	1 1/2	1 1/2
91955-10	1 1/2	6 1/2	1 1/2	1 1/2	1 1/2
91955-18	1 1/2	6 1/2	1 1/2	1 1/2	1 1/2



Hyvac 45

Fig. 2A

Hyvac 28

hit the intake of the pump when the cylinder of the pump is open to the intake. The conductance of various sizes of tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008, or may be determined from Fig. 3, in which $(L + \frac{4}{3}D)$ is plotted against Z , the conductance in cubic centimeters per second. L and D are the length and inside diameter of the tubes in centimeters.

The net speed of the system then may be found by solving the following relationship:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pump speed, taken from Fig. 1, and Z is the conductance of the tubing. The time required to evacuate a vessel of volume V is given by the formula:

$$T = \frac{2.3V}{S} \cdot K$$

where T is the time in seconds, V the volume expressed in liters, and S the average speed of the pump, expressed in liters per second, for operation over the pressure range of from atmospheric to final pressure. The factor K has values of 4, 5, and 6. The factor 4 is used if the final pressure is 100 microns, 5 for 10 microns, and 6 for 1 micron.

2.4 valves

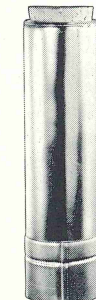
Metal vacuum valves and glass stopcocks are employed generally in the connecting line between the pump and the system for connecting the vacuum gage and for releasing the vacuum system when pumping is stopped. When metal pipes are used, a high-vacuum valve, such as No. 94551 or 94280, is recommended.

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of testing the pump and system for leaks by the pressure-rise method without disconnecting the pump from the line.

2.5 traps



No. 94005 Liquid air trap

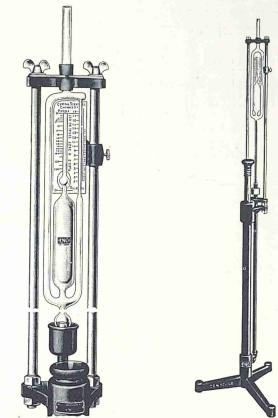


No. 15830 Dewar flasks

Extreme care must be taken to prevent solid particles from reaching the intake of the pump, as they will score the working parts of the pump and reduce its efficiency. If corrosive vapors are present in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap

also prevents any oil vapor (from the pump) from entering the system. A Cenco No. 94005 or No. 94006 Glass Trap is recommended. Either should be used in a No. 15830-3 Vacuum Flask. The refrigerant most commonly used in the vacuum flask is a mixture of solid carbon dioxide (dry ice) and acetone or ethyl alcohol.

2.6 gages



No. 94151 McLeod gage

The types of high vacuum gages commonly used in a system employing a Hyvac pump are the McLeod, Pirani, Discharge, and Thermocouple gage.

A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 min Hg to 1.6 mm Hg (0.5 microns Hg to 1600 microns Hg). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint. The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 microns and from 1 to 50 microns of mercury. The Thermocouple gage permits measurements in the range from 1 to 1000 microns of mercury. The Discharge gage operates within the range of 0.001 to 20 microns of mercury.

2.7 oil

The Hyvac is shipped with the oil drained from the reservoir. Oil is supplied for the first filling and for periodic oil changes. To fill the pump with oil, first remove the exhaust dome and fill through the opening, otherwise taken by the exhaust dome, up to the oil level sight gage. Turn the pump pulley several revolutions by hand while filling with oil. The oil level window indicates the correct oil level. If insufficient oil is used, a good seal around the vanes may not be maintained. *If too much oil is used, oil may back up through the pump trap and into the vacuum system.* It is recommended to take a final check on the oil level while the pump is running.

Pump Model	Oil Supplied with pump, Gallons	Oil required for one filling, Pints
Hyvac 2	0.75	2
Hyvac 7	0.50	3
Hyvac 14	1.00	5
Hyvac 28	1.00	7
Hyvac 45	1.25	9

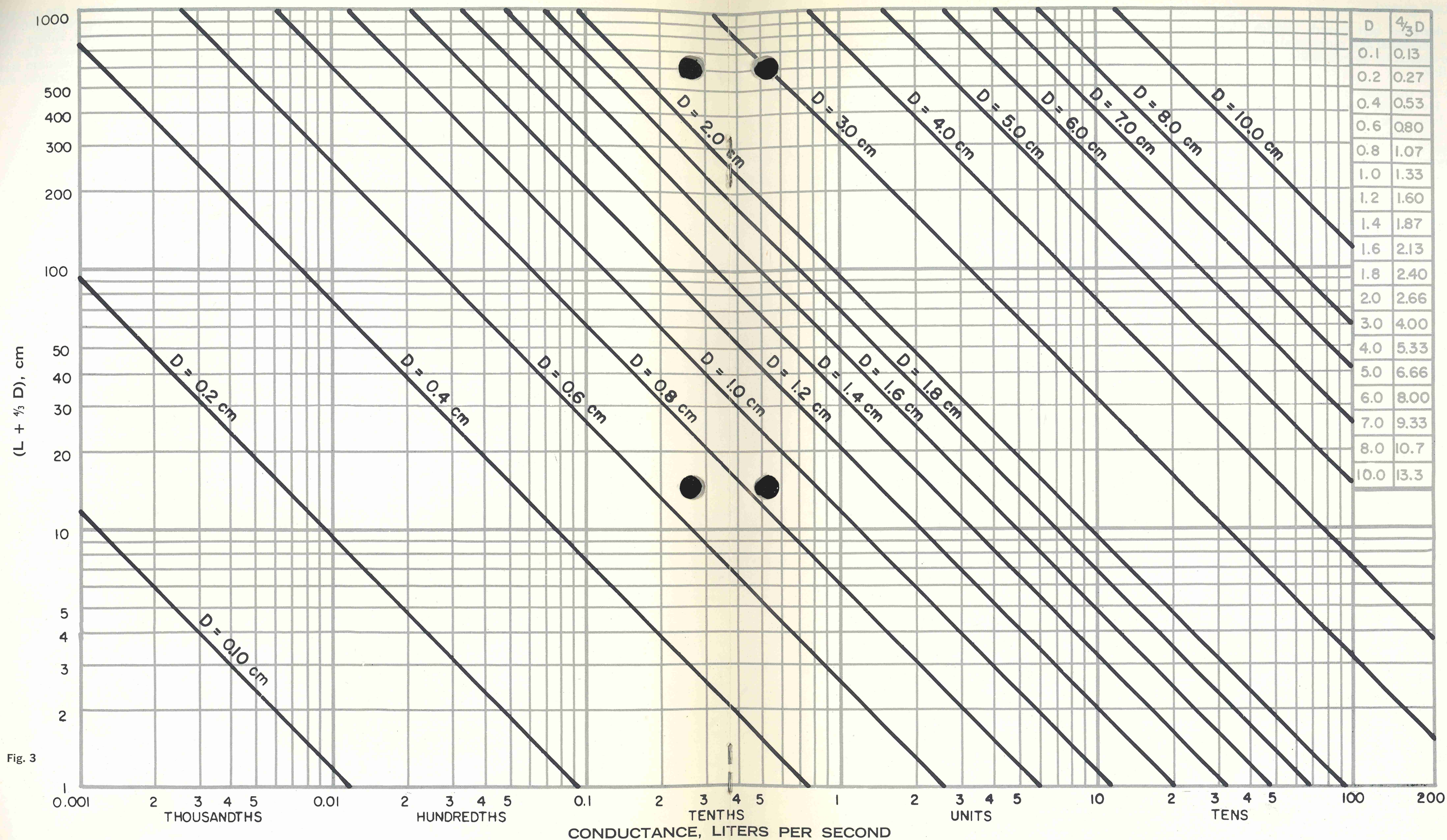


Fig. 3

TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently, the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain a pumping speed (S) as large as possible, the tube conductance (Z) must be very large when compared with the speed of the pump (S_1). This is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} S_1$$

Since at best S is only a fraction of S_1 , the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance (Z), shown in liters/sec., is plotted as abscissas against the quantity $(L + \frac{4}{3}D)$ in cm, as ordinates. In addition to the parameter D , the value of $\frac{4}{3}D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm long, having a diameter of 2 cm, is required. As it can be seen from the table, for $D = 2$, the value of $\frac{4}{3}D = 2.66$ cm. Referring to the curve, for $D = 2$ the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines spaced logarithmically, conductance of tubes having diameters other than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely $\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$ where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

2.8 belt guard

Cenco-designed belt guards furnish ideal protection for personnel and pump against damages which may be caused by objects falling on the belt or into the pulley.

Except for the base on the explosion-proof version of the Hyvac 45, Cenco No. 91955-10, all Cenco pump bases are drilled to receive these guards, which are supplied ready for mounting. Cenco Numbers for specific belt guards are listed in the "Accessory" section, Paragraph 5.1.

3 operation

3.1 general

If the pump has been installed properly, it will begin to pump as soon as the motor is energized. With larger pumps such as the Hyvac 14, 28, and 45, starting difficulty is sometimes encountered if air was not admitted to the pump when it was last turned off. Never leave a pump turned off for more than a few minutes while it is still connected to a vacuum.

Oil shooting from the exhaust dome of an operating pump indicates that the pump contains too much oil. Stop the pump and drain oil until the oil level comes to the proper height.

3.2 lubrication

When oil has become contaminated, it should be promptly changed. Oil can be removed by opening the drain, located at the front of the housing. Turn the shaft several revolutions to force out any remaining oil. Flush with clean Flushing Oil, No. 93060, at least once and then refill with new Hyvac Oil, No. 93050. The frequency of oil change is dependent upon the use of the pump. An oil change may be needed only once in six months if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosive or highly condensable vapors enter the pump.

When the pump is operated continuously, the oil temperature may reach 50° to 60°C. This temperature is normal for efficient operation of the pump.



3.3 gas ballast

The gas ballast feature has been incorporated in the Hyvac pumps to prevent contamination of the pump oil when condensable vapors are pumped. The gas ballast valve, located at the rear of the housing, allows regulation of the air flow (gas ballast) during the compression cycle of the stage. This ballast flow reduces the compression ratio of the vapor in the stage, thus preventing condensation of the vapor and emulsification with the oil.

If large amounts of water vapor are pumped and a large ballast flow is used, some oil mist will be discharged with the ballast air and vapor. Therefore, it is a good practice to pipe the exhaust outside to the atmosphere. For best performance, a simple condensing trap should be provided in the exhaust line as close to the pump as possible to prevent the condensate, which will form in the pipe, from running back into the pump.

The gas ballast pump is ideally suited for pumping all vapors which do not chemically attack or dissolve in the pump oil; water is a typical example. Even if contamination of the oil has occurred, the gas ballast pump is able to purify the oil, if the system is temporarily shut off from the pump and the pump kept running for a suitable length of time. The contaminated oil will continually enter the pump through the oil supply channel. This oil circulates into the high vacuum side, where the contaminant will evolve as vapor. This vapor then will be discharged with the ballast air as described before, until eventually all the contaminant has been expelled. For this reason, the oil of a pump employing the gas ballast does not have to be changed nearly as often as indicated in the preceding paragraph.

The following is a formula of maximum pumping rate without contamination of the pump oil for insoluble vapors:

$$W = DV \cdot \frac{P_a}{P_e - P_s} \cdot \frac{T_p}{T_a} \text{ (g/min)}$$

where:

T_p = pump temperature (°K) (taken as pump oil temperature)

T_a = ambient temperature (°K)

P_a = barometric pressure (mm Hg)

P_s = saturation pressure of pumped vapor at pump temperature T_p (mm Hg)

P_e = pressure under pump exhaust valve at instant of exhausting (mm Hg)

V = rate of dry gas ballast flow at atmospheric pressure P_a (lit/min)

D = density of pumped vapor at temperature T_p and pressure P_s (g/lit)

W = maximum safe mass rate for pumping vapors (g/min)

Solving for the special and frequent case of water vapor, and assuming a pressure of 850 mm Hg below the exhaust valve at instant of exhausting, and substituting the density of water vapor, we obtain:

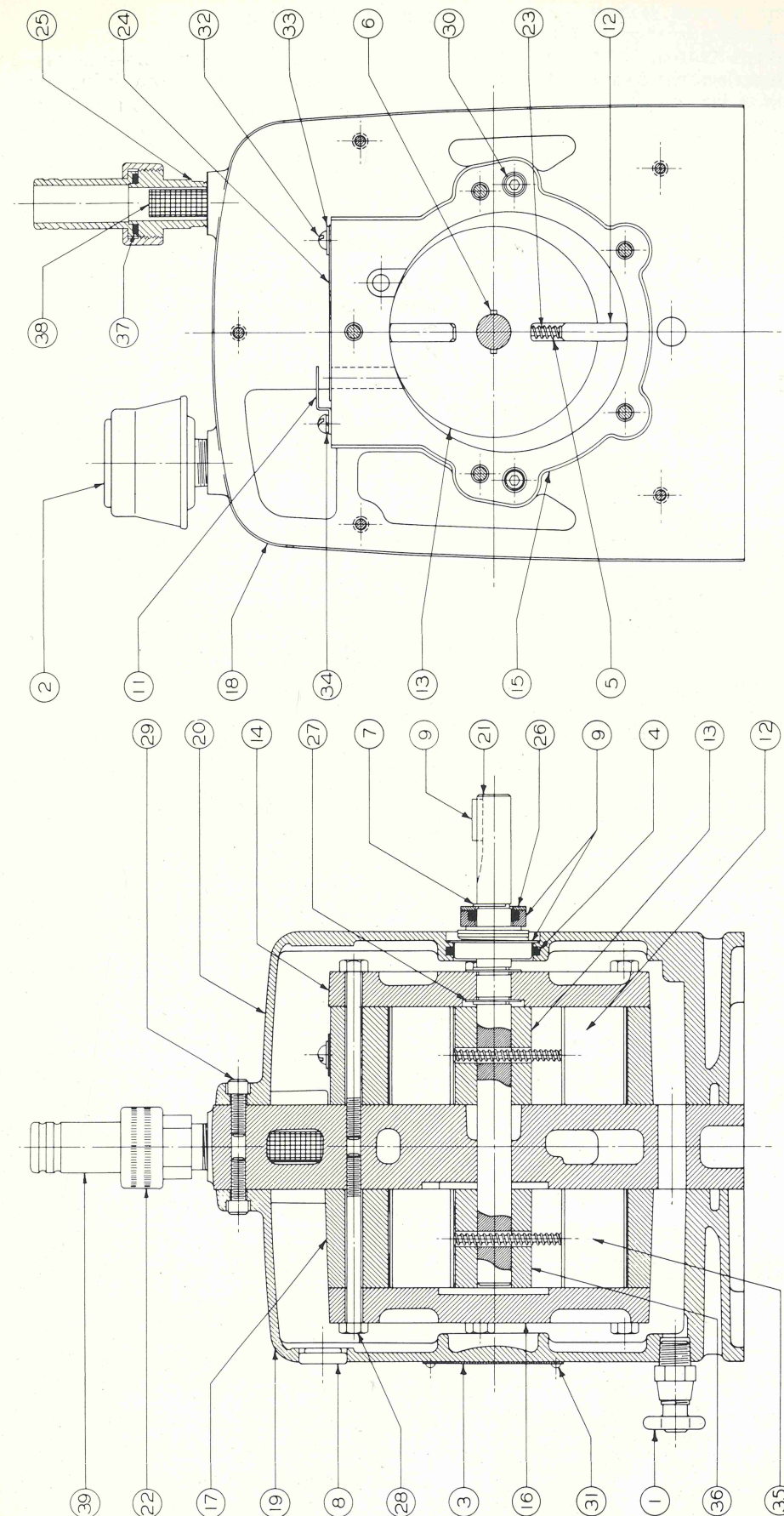


Fig. 4 Sectional View of Hyvac 2, 7, and 14

$$W_{\text{water vapor}} = 0.289 \left(\frac{V}{T_a} \right) \left(\frac{P_a P_s}{850 - P_s} \right) \text{ (g/min)}$$

Using 10 lit/min gas ballast flow, the following maximum vapor pumping rates are obtained when no condensation is in the pump:

Pump Temperature °C	50	60	70	80
Maximum water vapor pumping rate with zero humidity in ballast air (g/min)	0.91	1.60	2.84	5.38
With 100% humidity in ballast air (g/min)	0.72	1.39	2.59	5.08

For above data

$$P_a = 760 \text{ mm Hg;}$$

$$T_a = 20^\circ\text{C} = 293^\circ\text{K}$$

If the ultimate vacuum of the pump is not required, it is possible to obtain almost noiseless operation by "cracking" open the gas ballast valve a very small amount. The ultimate pressure which can be obtained in this instance is approximately 30 microns.

4 maintenance

4.1 general

The maintenance requirements of the Cenco Hyvac Pump will vary with application. Proper lubrication is the most important factor in securing reliable performance (See Paragraph 2.7).

If a pump is connected into a normal leak-free system, there should be no malfunction that might not be remedied by simple adjustments. If a pump fails to function, the cause usually can be attributed to a minor mechanical failure, such as a broken spring, a sticking vane, or worn valve release, rather than to misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal operation, where no corrosive vapors are encountered, there will be no decrease in the efficiency of a pump over a period of several years.

4.2 shaft seal

The seal on the pump shaft, symbol 21 in Fig. 4, consists of a "Truarc" ring, (7), a thrust washer (26), a shaft seal (9), and an "O" ring, (4). Remove the "Truarc" ring, the thrust washer, the shaft seal, and finally the "O" ring, in this order. Before assembling or making a replacement, apply a thin film of pump oil to the pump shaft. Also apply the same amount of oil to the inner surface of the shaft seal. Replace the shaft seal carefully so as not to damage the inner surface of the rubber seal ring. Push the seal back into the cavity until it contacts the "O" ring. Replace the thrust washer, and force the washer and spring over the groove in the shaft. Finally, replace the "Truarc" ring.

4.3 belt

The belt adjustment in mounted pumps is made by loosening the bolts in the base of the motor and moving the motor in the required direction. The belt should be just tight enough to prevent slippage while operating. A little slippage on starting is desirable.

4.4 repairs

Fig. 4 shows cross sectional views of the Hyvac Pump. Fig. 5 shows an exploded view of the pump and all its components. Paragraph 5.1 lists the part number for each component of the pump. When ordering replacement parts, please give the exact part number. For repairs to the pump other than the replacement of the shaft seal, it is strongly recommended that the pump be returned to the factory, especially when adequate shop facilities are not available.

5 accessories and replacement parts

5.1 accessories

McLEOD GAGE, dual range, for calibrating electronic gages, making absolute pressure readings, and other vacuum applications where extreme accuracy is necessary. One range reads directly from 0.5 to about 200 microns, the other to about 1.6 mm. Requires 10 lbs. of mercury.

No. 94151 McLeod Gage.....\$205.00

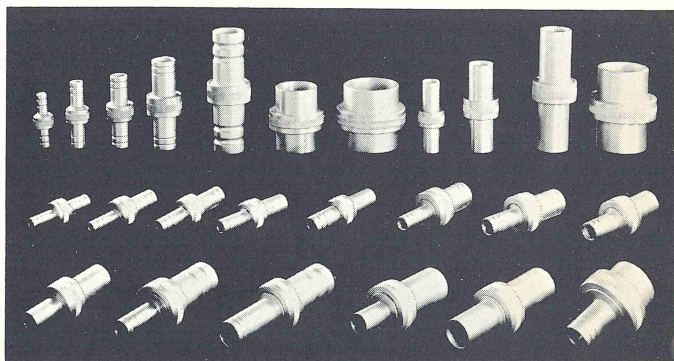
VACUUM PUMP OIL especially processed to maintain the guaranteed performance of our Hyvac pumps. Six gallon cans to a case.

No. 93050-3 Light Pump Oil, 1 gallon.....\$2.25

BELT GUARDS for personnel protection and prevention of foreign objects becoming entangled in a belt or pulley.

No. 91508 for Hyvac 2.....\$15.50

No. 91708 for Hyvac 7, 14, 28, 45 15.50



A complete line of vacuum connectors and couplings designed specifically for high vacuum applications. For a complete description, including dimensions, request booklet No. 327.

SOLENOID VALVES for installation on the intake port of Cenco pumps to automatically close off the evacuated system when the pump motor is stopped. Withstand temperature to 180°F. Maximum operating range 15 pounds per sq. in. Fits directly to the pump intake after nipple is removed. Model 1 used with Hyvac 2, Models 2 & 3 with Hyvac 7, and Models 4 & 5 with Hyvac 14 & 28. All operate on 60 cycle AC, 10 watts holding power.

No. 94280-1 115V, 3/8 IPS Thread.....	\$23.75
No. 94280-2 115V, 1/2 IPS Thread.....	25.25
No. 94280-3 230V, 1/2 IPS Thread.....	26.00
No. 94280-4 115V, 3/4 IPS Thread.....	26.50
No. 94280-5 230V, 3/4 IPS Thread.....	27.50

DEMOUNTABLE TRAP, a stainless steel trap for removing moisture and other condensable vapors from high vacuum systems. Can be quickly installed or removed.....No. 94001

ALL-METAL LIQUID AIR TRAPS — Devices for "freezing out" moisture, and condensing vapors which might be present in a vacuum system. The traps can be easily connected to the system and the condensate easily removed from the trap.

The Cenco No. 94009 liquid air traps are available in six models. Models 94009-1, 2, and 3 are made of aluminum and are designed for operation within a vacuum range from atmospheric pressure down to 1×10^{-4} torr. Models 94009-4, 5, and 6 are made of stainless steel, and operate within a vacuum range from atmospheric pressure down to 1×10^{-6} torr. The design of the trap is such that it will not materially retard the conductance of the vacuum system. The entire assembly is welded (silver-soldered for the stainless steel models) vacuum tight.

Specifications All dimensions given in inches.

CENCO NOS.	94009-1 94009-4	94009-2 94009-5	94009-3 94009-6
Effective Trap Length	7 1/2	7 1/2	7 1/2
*Syphon Tube OD	1	1 1/4	1 3/4
*Intake Nipple OD	1	1 1/4	1 3/4
Trap Tube (collector) OD	2	2 1/4	3
Overall Length	12	12	12
*For: Water Tubing	3/4	1	1 1/2
Mechanical Tubing	7/8	1 1/8	1 5/8
Rubber Tubing	1	1 1/4	1 3/4

No. 94009-1	\$44.50
No. 94009-2	49.50
No. 94009-3	55.00
No. 94009-4 through -6.....	Price on application

VACUUM PUMP EXHAUST FILTER — To trap oil vapors and oil droplets which may be exhausted from mechanical vacuum pumps.

The exhaust filter is the combination of an exhaust dome and a filter element which collects any oil

mist exhausted from a vacuum pump. The filter element consists of several layers of fine wire mesh and a layer of a non-organic fiber. Oil which is being separated from the air at exhaust port is drained back to the vacuum pump.

Specifications	93121-1	93121-2	93121-3
Outside Diameter, IN	3.5	6	7
Overall Height, IN	5.5	8	9 1/8
Inlet Connection	1/2" IPS	3/4" IPS	1 1/2" IPS
Maximum Capacity, CU FT/MIN	3.5	7	16
Used with Cenco Vacuum Pumps:	Hyvac 7 Megavac *Hyvac 2	Hyvac 14	Hyvac 28 Hyvac 45

*Used with Adapter

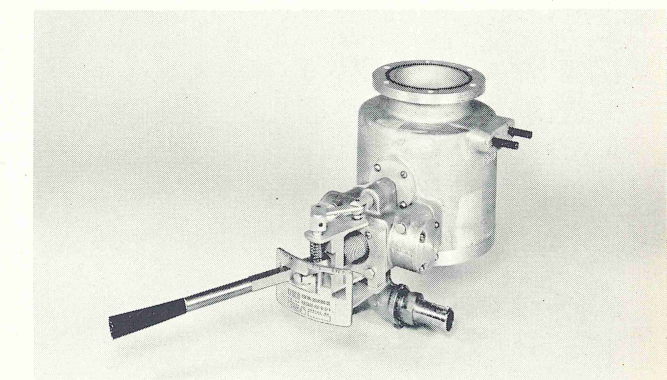
No. 93121-1	\$12.00
No. 93121-2	28.90
No. 93121-3	47.00

REPLACEMENT FILTER ELEMENTS

No. 93123-1	\$ 3.60
No. 93123-2	6.25
No. 93123-3	8.25

EXTRA HEAVY WALL, RED TUBING, CENCO — For filter and vacuum pump connections, mercury leveling bulbs, etc. Made to our special formula for high vacuum work. Sold in minimum lengths of 5 feet in sizes 1 to 3 and 1 foot in sizes 6 to 11.

No. 18204 Dash No.	1	2	3	6	8	11
ID, inch	1/8	3/16	1/4	3/8	1/2	5/8
Wall thickness, inch	3/32	3/16	1/8	3/16	1/4	5/16
per ft.	\$0.30	0.48	0.52	1.05	1.50	1.70



THREE-WAY VACUUM VALVE provides rapid, positive single control mechanical switching for the complete diffusion-mechanical pumping system. Mounts directly between the pump plate and a 4" diffusion pump. Fore line and roughing lines are equivalent to 1" pipe. Built-in water-cooled baffle minimize back streaming. Write for Booklet 328. No. 94552 Three Way Valve..... \$395.00

HYVAC 5.2 replacement parts
 2 X SHAFT SEAL
 NEW P36378
 GASKET P36327

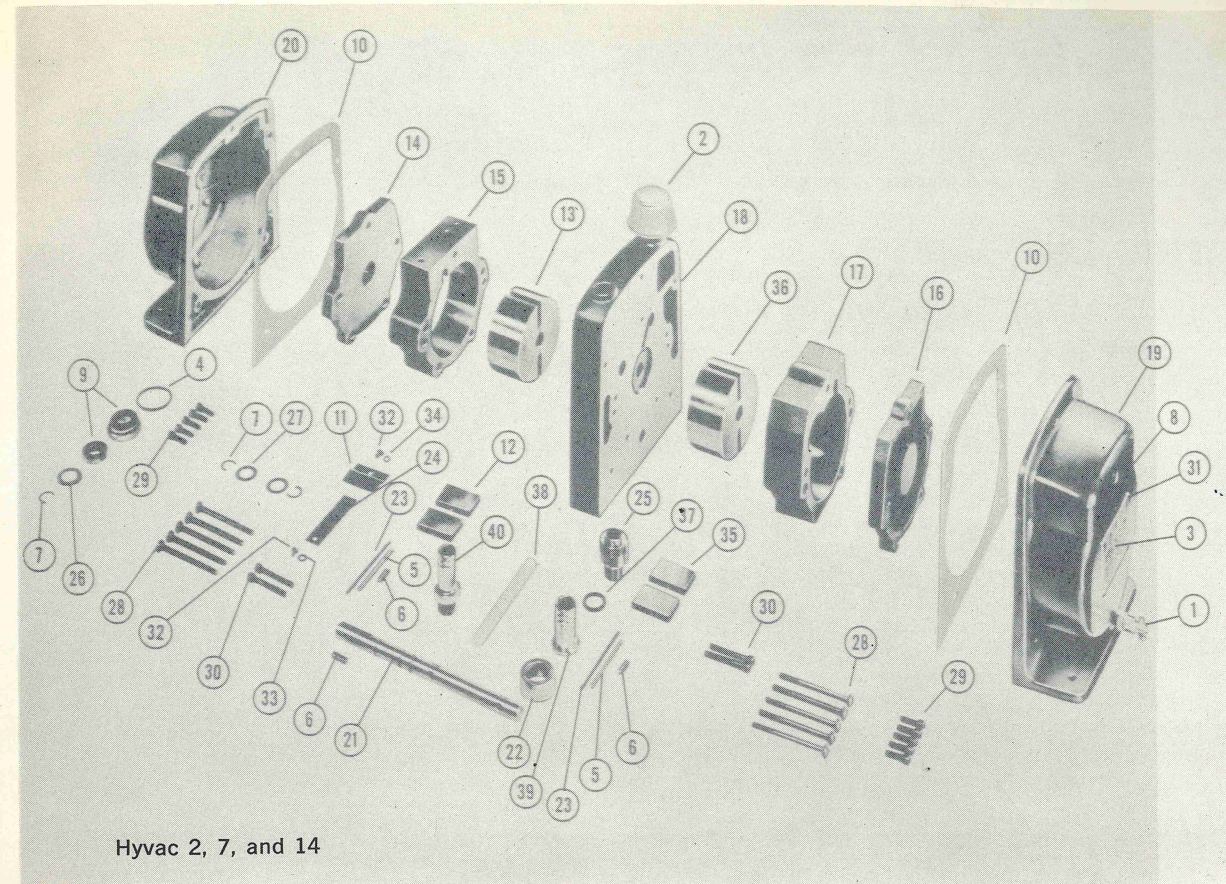
HYVAC 14 P36379 COMPLETE

A34 BELT

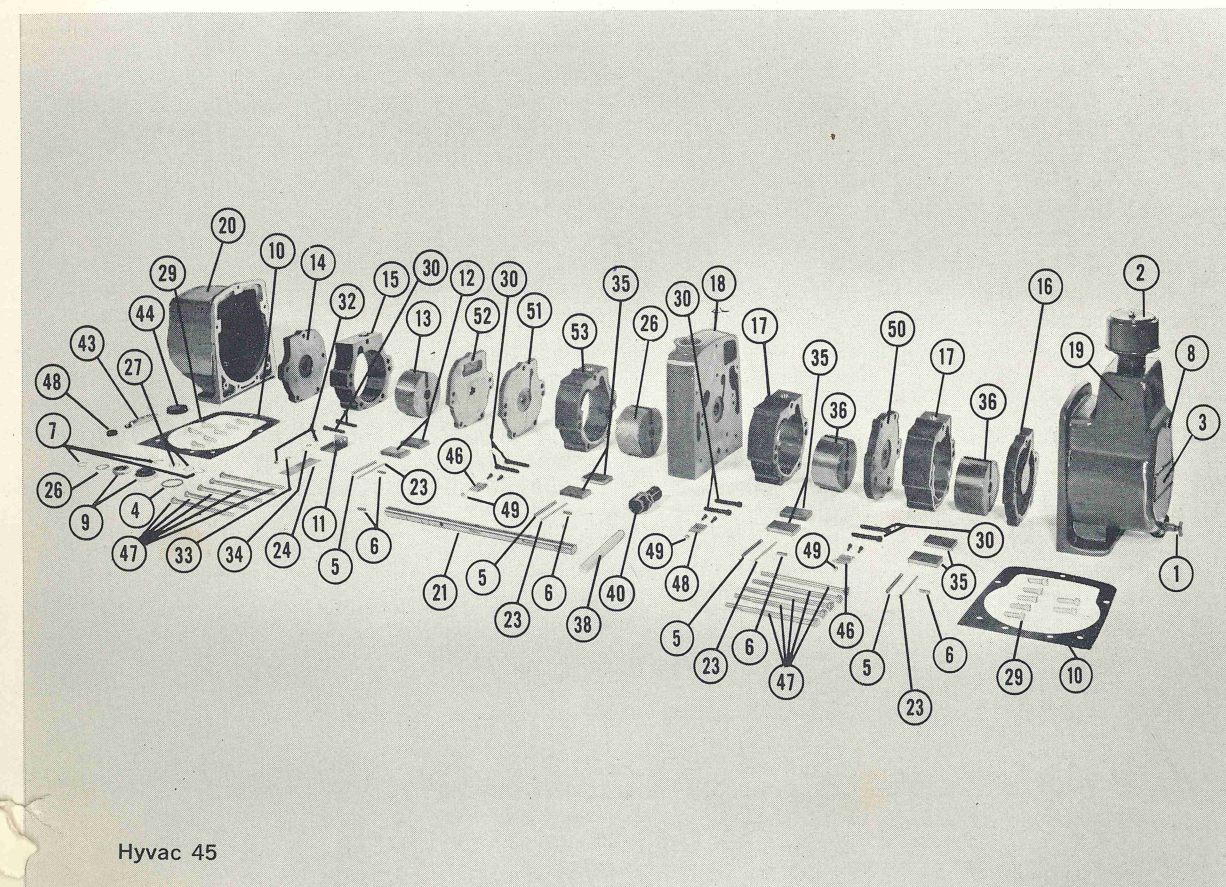
SYMBOL	PART'S NAME	NO. REQ'D PER PUMP	PART NO.				
			Hyvac 2.	Hyvac 7	Hyvac 14	Hyvac 28	Hyvac 45
1	Drain Cock	1	P13116	P13116	P13116	P13116	P13116
2	Exhaust Dome	1	P35352	P35345	P35341	P35617	P35617
3	Direction Plate	1	P25220	P25252	P25212	P25329	P25348
4	"O" Ring, Shaft Seal	1	P27080	P27080	P27082	P27082	P27082
5	Vane Spring	2	P28066	P28065	P28064	P28064	P28064
6	Shaft Key	3	P29313	P29313	P29313	P29313	P29313
7	Crescent Truarc Ring	3	P29260	P29260	P29258	P29258	P29258
8	Oil Level	1	P35291	P35291	P35291	P35291	P35291
9	Shaft Seal	1	P35332	P35332	P35334	P35334	P35334
10	Housing Gasket	2	91310-2	91310-7	91310-14	91310-14	91310-14
11	Valve Limiter	1	P60827	P61018	P61018	P61018	P61018
12	Exhaust Vane	2	P60787	P60776	P60765	P60765	P60765
13	Exhaust Rotor	1	P60788	P60777	P60766	P60766	P60766
14	Exhaust End Plate	1	P60789	P60778	P60767	P60767	P60767
15	Exhaust Stator	1	P60790	P60779	P60768	P60768	P60768
16	Intake End Plate	1	P60791	P60780	P60769	P60769	P61143
17	Intake Stator	1	P60792	P60781	P60770	P60770	P60770
18	Center Plate	1	P60793	P60782	P60771	P61131	P61151
19	Drain Housing	1	P60794	P60783	P60772	P61118	P61118
20	Seal Housing	1	P60795	P60784	P60773	P60773	P61150
21	Shaft	1	P60797	P60786	P60775	P61129	P61144
22	Vacuum Coupling Nut	1	---	P63516	P63519	---	---
23	Spring Pin	2	P63503	P63501	P63499	P63499	P63499
24	Flutter Valve	1	P65471	P65470	P65532	P65532	P65532
25	Coupling Adapter	1	---	P63545	P63546	---	---
26	Thrust Washer	1	P78031	P78031	P78032	P78032	P78032
27	Thrust Washer	2	P78034	P78034	P78033	P78033	P78033
28	1/4-20 x 2 1/4 Hex. Hd. Steel Screw	10	P29315	---	---	---	---
28	1/4-20 x 3 Hex. Hd. Steel Screw	10	---	P29316	---	---	---
28	5/16-18 x 3 1/2 Hex. Hd. Steel Screw	10	---	---	P29317	P29317	---
29	1/4-20 x 3/4 Soc. Hd. Steel Screw	10	✓	✓	---	---	---
29	5/16-18 x 1 Soc. Hd. Steel Screw	14	---	---	✓	✓	✓
30	1/4-20 x 1 Soc. Hd. Steel Screw	4	✓	---	---	---	---
30	1/4-20 x 1 3/4 Soc. Hd. Steel Screw	4	---	✓	---	---	---
30	5/16-18 x 2 Soc. Hd. Steel Screw	8	---	---	✓	✓	✓
31	No. 2 x 5/16 Rd. Hd. Drive Screw	4	✓	✓	✓	✓	✓
32	10-24 x 1/4 Rd. Hd. Steel Screw	2	✓	✓	✓	✓	✓
33	No. 10 Bright Steel Burr	1	✓	✓	✓	✓	✓
34	No. 10 Split Lock Washer	1	✓	✓	✓	✓	✓
35	Intake Vane	2	P60787	P60776	P60765	P60765	P60765
36	Intake Rotor	1	P60788	P60777	P60766	P60766	P60766
37	"O" Ring, Coupling Note: 3 Extra Supplied	1	---	94236-4	94236-5	---	---
38	Intake Screen	1	P29295	P29296	P29297	P29492	P29513
39	Coupling Hose Nipple	1	---	P63556	P63558	---	---
40	Hose Nipple	1	P69263	---	---	P63764	P63765
43	Gas Ballast Valve	1	P67416	P67416	P67416	P67416	P67416
44	Gas Ballast Valve Knob	1	P26139	P26139	P26139	P26139	P26139
45	Belt	1	P27185 ¹	P27114 ²	P27113	P27113	P27113
46	Valve Limiter	3	---	P61108	P61108	P61108	P61108
47	5/16-18 x 6 1/2 Hex. Hd. Stl Cap Screw	10	---	---	---	P29458	P29458
48	Gas Ballast Grommet	1	P27120	P27120	P27120	P27120	P27120
49	Relief Valve Ball	3	---	P29012	P29514	P29514	P29514
50	Intermediate Plate	1	---	---	---	P61119	P61153
51	Exhaust Side Intermediate Plate No. 1	1	---	---	---	---	P61148
52	Exhaust Side Intermediate Plate No. 2	1	---	---	---	---	P61149
53	Exhaust Side Intake Stator	1	---	---	---	---	P61152
54	Pump Pulley	1	P35460	P29491	P29273	P29273	P29273
55	Transfer	1	P35239	P35239	P35239	P35239	P35239
56	Exhaust Baffle	1	---	---	P65767	---	---

All items are illustrated except those numbered higher than 40 in the upper photo and Nos. 45, 54, 55, 56, 57, and 58 in the lower photo.

¹Below serial No. 4000, belt P27111 is used. SPRING FOR GAS BALLAST VALVE P28073
²Below serial No. 3000, belt P27112 is used. OIL BARRIER FOR HYVAC 14 P65767



Hyvac 2, 7, and 14



Hyvac 45

Fig. 5 Exploded View of Hyvac Pumps

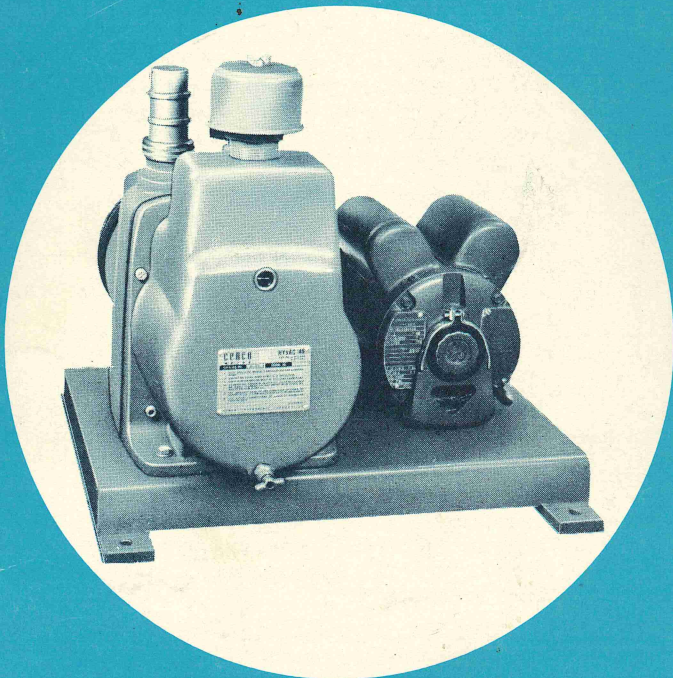
CENTRAL SCIENTIFIC COMPANY
a division of Cenco Instruments Corporation
2600 S. KOSTNER AVENUE CHICAGO, ILLINOIS 60623
Telephone: 277-8300 Area Code 312



mechanical
vacuum pumps

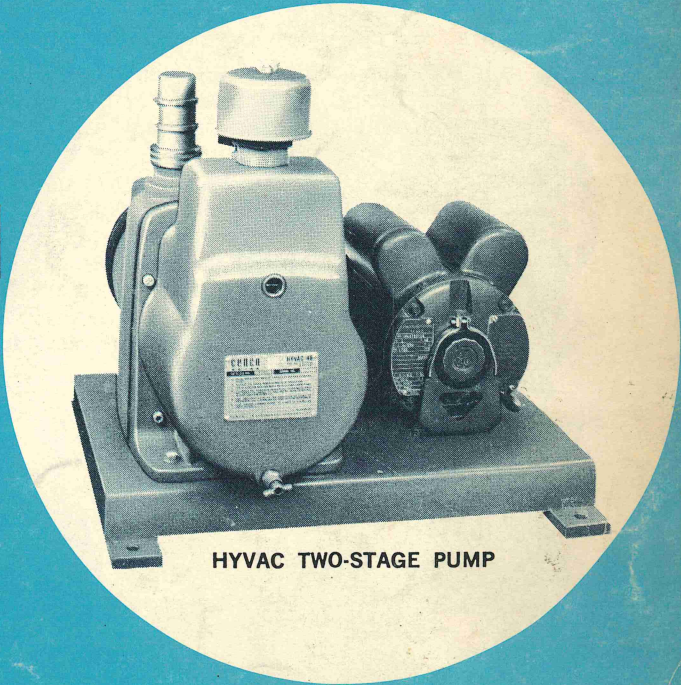
A COMPLETE LINE OF HIGH VACUUM PUMPS, GAGES, SYSTEMS, & COMPONENTS
MAKERS OF THE WORLD RENOWNED HYVAC® PUMPS

CENCO HYVAC PUMP

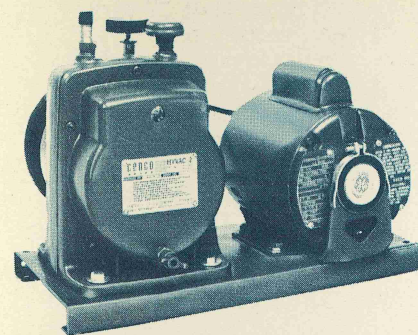


A two-stage, oil sealed mechanical pump of the internal moving vane design for pumping down to 0.05 microns of vacuum with high speed. Its reasonable cost and size make this dependable pump ideal for research and educational laboratory applications. It has also found wide acceptance in the chemical process industry where a continuous high vacuum is required.

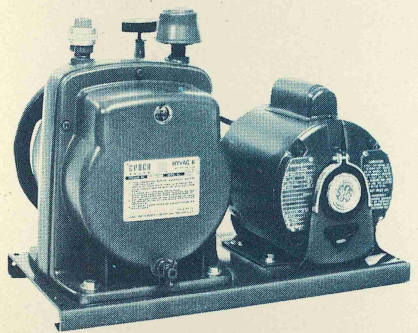
		GUARANTEED VACUUM (millitorr)	CAPACITY		BOOKLET
			at atmosphere (liters per min.)	at 1 millitorr (liters per min.)	
SINGLE STAGE PUMPS	Hyvac 7	10.0	79	—	329
	Hyvac 14	5.0	140	—	
	Hyvac 28	5.0	280	—	
	Hyvac 45	5.0	450	—	
	Pressovac	15.0	35	—	325
	Blower Pump	3 IN. Hg.	35	—	326
DOUBLE STAGE PUMPS	Hyvac	0.3	10	5	320
	Hyvac 2	0.1	25	13	321
	Hyvac 4	0.05	48	25	
	Hyvac 6	0.1	65	30	
	Hyvac 7	0.1	79	35	
	Hyvac 14	0.1	140	75	
	Hyvac 28	0.05	280	150	
	Hyvac 45	0.05	450	280	319
	Hyvac 150	0.05	1500	1275	
	Hyvac 225	0.05	2250	1800	
	Hyvac 300	0.05	3000	2250	
	Megavac	0.1	57	22	323
	Hypervac 23	5.0	240	—	324
	Hypervac 25	0.1	264	120	
	Hypervac 100	0.1	960	660	



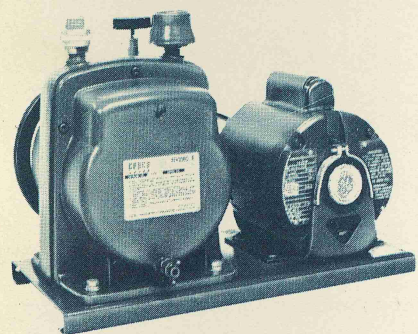
HYVAC TWO-STAGE PUMP



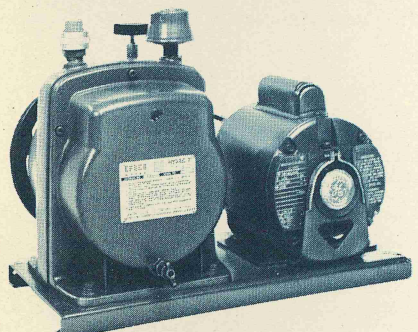
Hyvac 2



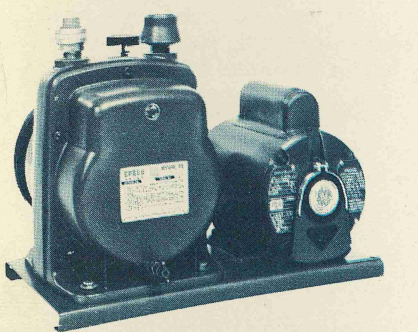
Hyvac 4



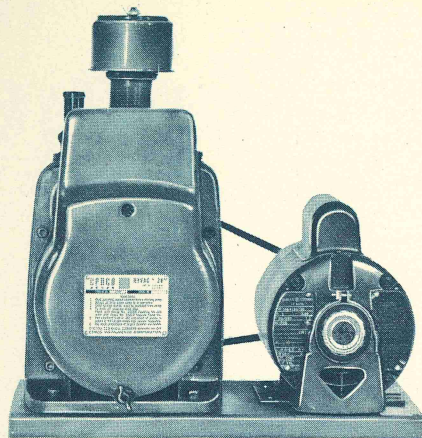
Hyvac 6



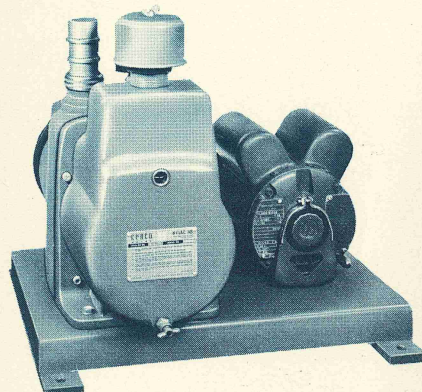
Hyvac 7



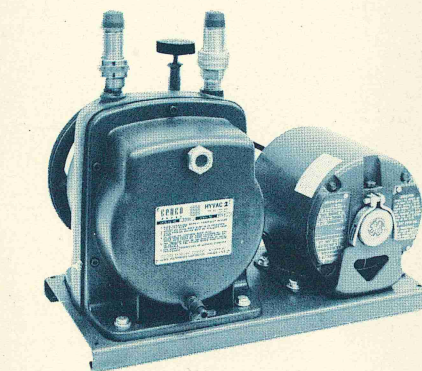
Hyvac 14



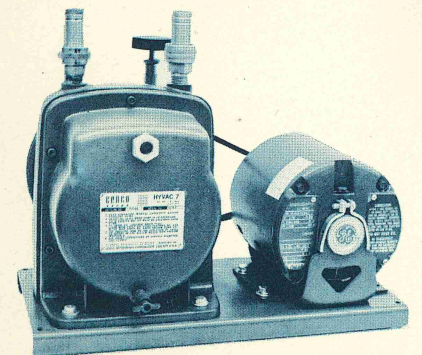
Hyvac 28



Hyvac 45



Hyvac 2 for Closed System Service



Hyvac 7 for Closed System Service

Cenco Double Stage Vacuum Pumps

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1 introduction

1.1 General: The Cenco Hyvac 2, 4, 6, 7, 14, 28, and 45 Pumps are two-stage, high-capacity mechanical vacuum pumps based on the internal-vane principle. Combining quiet, vibrationless operation, and high pumping speed with low ultimate pressure, these pumps are best suited for heavy-duty vacuum work, such as evacuating space chambers, pumping down large vacuum furnaces, and backing ultra-vacuum diffusion pumps in environmental testing and space condition simulation. They may also be used as roughing pumps in general-purpose high vacuum applications and as forepumps in conjunction with diffusion pumps, such as Cenco Nos. 93415 and 93416.

Specifically, the Cenco Hyvac Pumps can be used in the following high-vacuum commercial applications:

- **Vacuum Metallurgy** — Thermal Reduction, Distillation of Metals, Vacuum Sintering, Heat Treatment, Vacuum Melting
- **Vacuum Dehydration** — Blood Plasma, Biologicals, Foods
- **Vacuum Evaporation** — Low-Reflection Coatings on optical surfaces and reflecting surfaces, Decorative Coatings, Electrically Conductive Coatings
- **Vacuum Sputtering** — Coating of Non-Conductors
- **Vacuum Distillation** — Distillation Point Reduction, Molecular Distillation
- **Vacuum Impregnation** — Condensers, Coils, Transformers, Cables, and other electrical insulating materials
- **Miscellaneous** — Manufacture of Refrigerators, Bellows-type Barometers, Vapor-operated Thermometers; Television Receivers, Vacuum Bottles, etc.; Evacuation of High-voltage X-ray Tubes, Large Magnetrons, Cathode-Ray Tubes.

1.2 Features of the Cenco Hyvac Pumps

- High-conductance, internal connections between intake and exhaust stages for optimum pumping performance.
- Arrangement of lubrication ducts for positive sealing and effective lubrication of all rotating components of the pump.
- Internal relief valve arrangement for starting the pump against an evacuated vacuum system.
- Standard pipe thread inlet connections.

2 principle of operation

Since the Hyvac 2, 4, 6, 7, 14, 28 and 45 Pumps incorporate two, distinct, single stages mounted back to back, to understand how a two-stage pump works, it is only necessary to understand the operating principle of a single-stage pump.

A typical, internal-vane, vacuum pump consists of a motor-driven cylindrical rotor eccentrically mounted within a larger housing, or stator. Two spring-loaded vanes are mounted in the rotor, parallel to its axis, in diametrically opposed slots. The vanes bear against the wall of the stator under spring pressure and centrifugal action. The eccentric

mounting of the rotor provides a permanent point of contact between stator and rotor and divides the stator in two sections, or stages: intake and exhaust. A thin film of oil at the point of contact maintains effective vacuum sealing, thus preventing the passage of gas between stages. Two openings in the stator serve as gas intake and exhaust ports. The intake port is connected to the system to be evacuated.

Figure 1 illustrates the internal vane principle. As the pump is driven by a motor, the rotor turns, and the spring-loaded vanes slide in and out of their slots, maintaining positive contact with the wall of the stator throughout every revolution. As a result, gas in the space between the two vanes is pushed forward, compressed to atmospheric pressure, and expelled through the exhaust while additional gas is sucked in through the intake.

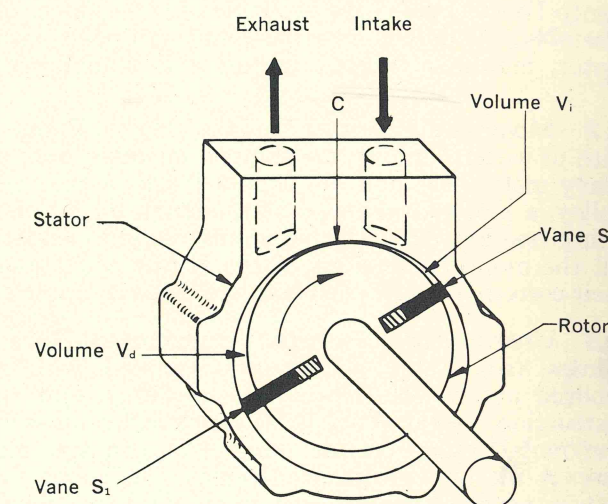


Fig. 1—Operating principle of an internal-vane vacuum pump

As the rotor turns, the volume behind Vane S increases from the instant vane S slides past the sealing area, or contact point C. This increasing volume V_i allows more gas from the system being evacuated to enter the intake stage. At the same time, the volume V_d ahead of vane S_1 decreases, thereby forcing gas to be compressed and expelled from the exhaust stage. The compressed gas is kept from entering the intake stage by the oil seal at the contact point C. A single stage pump of this type produces a vacuum of about 5 millitorr.

A typical two-stage vacuum pump incorporates a high-vacuum stage and a roughing stage, connected in series. The stages are mounted side by side and are separated by a common wall—ground plane parallel—through which a hole has been drilled. The hole serves as both the exhaust port of the high-vacuum stage and the intake port of the roughing stage. While volume V_d in the former is decreasing, air is being expelled in volume V_i of the roughing stage. The air in the volume V_d of the high-vacuum stage is not compressed appreciably; as a result, leakage into the high-vacuum stage is minimized. A two-stage pump of this type produces a vacuum of 1 millitorr or better.

3 specifications

3.1 Pump Data: The speed-pressure characteristics of the Cenco Hyvac Pumps are illustrated in Fig. 2. The following table lists additional pump data and specifications:

Pump Model	Hyvac 2	Hyvac 4	Hyvac 6	Hyvac 7	Hyvac 14	Hyvac 28	Hyvac 45
Pump speed (rpm)	580	325	440	525	525	525	550
Capacity at atmospheric pressure (liter/min.)	25	48	65	79	140	280	450
Capacity at 1 millitorr (liter/min.)	13	25	30	35	75	150	280
Guaranteed vacuum (millitorr)	0.1	0.05	0.1	0.1	0.1	0.05	0.05
Merit Factor, (%) ¹	52	54	46	44	54	54	62
Gas Ballast	optional	yes	yes	yes	yes	yes	yes
Motor Horsepower, hp	0.25	0.33	0.33	0.33	0.50	1.00	1.50

¹The merit factor is the ratio of the pumping speed at one millitorr to the pumping speed at atmospheric pressure.

Cenco Hyvac Pumps are available in three stages of assembly: mounted on a base and equipped with motor, mounted without motor, and unmounted.

3.2 Mounted Pumps: Mounted Hyvac Pumps, with or without motor, are shipped mounted onto a heavy metal base and are supplied with a grooved pulley, a molded rubber V belt, enough oil for one filling (see Section 5.7), and an instruction booklet. All the mounted versions of the Hyvac series and their corresponding Cenco Nos. are listed in Table I.

3.3 Unmounted Pumps: Unmounted Hyvac Pumps (see Table below) are supplied with a grooved pulley, enough oil for one filling, and an instruction booklet. Four holes are provided on each unmounted pump for fastening it onto a suitable base. A motor with grooved pulley and rubber V belt is needed to drive the pump at operational speed. The motor should have the same hp rating as that supplied with the Hyvac mounted-series pumps. For specifications, see Section 3.1 and Table II. For specific needs, special motors are available from Cenco on request. Unmounted Hyvac pumps are listed in the table below.

Cenco No.	Model	Gas Ballast
91300	Hyvac 2	No
91306	Hyvac 2	Yes
91480	Hyvac 4	Yes
91490	Hyvac 6	Yes
91502	Hyvac 7	Yes
91700	Hyvac 14	Yes
91900	Hyvac 28	Yes
91950	Hyvac 45	Yes

3.4 Pumps For Closed System Service: In addition to the unmounted models listed above, there are two other Hyvac pumps, Cenco No. 91301 and 91501, which are used to transfer inert gases, such as He₃, in a closed system without incurring any loss to the atmosphere. These unmounted pumps are supplied without gas ballast, but with all the other accessories of the Unmounted Hyvac 2 and Hyvac 7 Pumps.

Cenco No.	Model	Gas Ballast
91301	Hyvac 2	No
91501	Hyvac 7	No

4 description

The Cenco Hyvac 2, 4, 6, 7, 14, 28, and 45 Pumps are two-stage, series-connected, internal-vane, mechanical vacuum pumps. In operation, rotary motion is imparted to the pump mechanism by a belt drive connected to a powerful, electric motor. An all-metal belt guard completely encloses the belt drive for personnel safety.

The two stages, intake and exhaust, consist of cylindrical chambers in which rotors are mounted in the manner indicated in Section 2.

Lubricating oil for the exhaust stage enters through the bearing and oil holes in the exhaust endplate. Oil flow to the intake stage is controlled by the centerplate bearing and degassed by the exhaust stage before it is allowed to reach the intake stage. The intake nipple and exhaust dome are connected to the centerplate of the pump. The centerplate contains a large intake volume so that oil will not "back up" into the system if the pump is stopped and left connected to the system under vacuum for a long period of time. The intake and exhaust stages are supported by the centerplate. Around the stages, and bolted to the centerplate, are the two housings. The housings contain the oil bath, in which both stages are submerged.

The oil bath insures a vacuum-tight seal of the stages; cools the pump interior; and lubricates the moving parts through the oiling holes. The lubricating oil is degassed by the exhaust stage before it is allowed to reach the intake stage. Eventually, the oil becomes contaminated with volatiles and water droplets, and it must be replaced.

To prevent contamination of the pump oil when condensable vapors are pumped, a gas ballast feature has been incorporated in the Hyvac pumps. The gas ballast valve, located at the rear of the housing, allows regulation of an inlet flow (gas ballast) of atmospheric air during the compression cycle of the stage. This ballast flow reduces the compression ratio of the vapor in the stage, thus preventing condensation of the vapor and emulsification with the oil. Mounted on the pump is an exhaust-filter dome that effectively traps oil in the exhaust.

Mounted on the two housings are the drain cock, the oil level sight gage, and the oil shaft seal.

The Pumps for Closed Service Systems, Cenco Nos. 91301 and 91501, are basically similar to the Hyvac 2 and 7 Pumps just described, but for the following modifications: The shaft seal is replaced by a compound shaft seal housed in a special seal box. The shaft is extended to allow for the insertion of the compound seal. Drain housing and seal housing are specially sealed to meet requirements for pumping inert gases. Intake nipple is replaced by a nipple coupling to facilitate vacuum connection. Exhaust dome is replaced by a nipple coupling for closed system service. The gas ballast has been eliminated. In addition to the pump oil level indicator, these pumps have a shaft seal oil level indicator on the seal box.

Table I
HYVAC MOUNTED-PUMP SERIES: MODEL AND CENCO NUMBERS

Without Gas Ballast	With Gas Ballast							MOTOR RATING	
HYVAC 2 Cenco No.	HYVAC 2 Cenco No.	HYVAC 4 Cenco No.	HYVAC 6 Cenco No.	HYVAC 7 Cenco No.	HYVAC 14 Cenco No.	HYVAC 28 Cenco No.	HYVAC 45 Cenco No.	Voltage, Volts	Type Cycles
91305-1	91308-1	91482-1	91492-1	91506-1	91705-1	91905-1	91955-1	115/230	60
91305-7	91308-7	91482-7	91492-7	91506-7	91705-7	91905-7	91955-7	115/230	50
		91482-10*	91492-10*	91506-10*	91705-10*	91905-10*	91955-10*	115/230	60
91305-10*	91308-10*							115	60
91305-18	91308-18	91482-18	91492-18	91506-18	91705-18	91905-18	91955-18	220/440	60
91305-23	91308-23	91482-23	91492-23	91506-23	91705-23	91905-23	91955-23	no motor supplied	

* Explosion-Proof

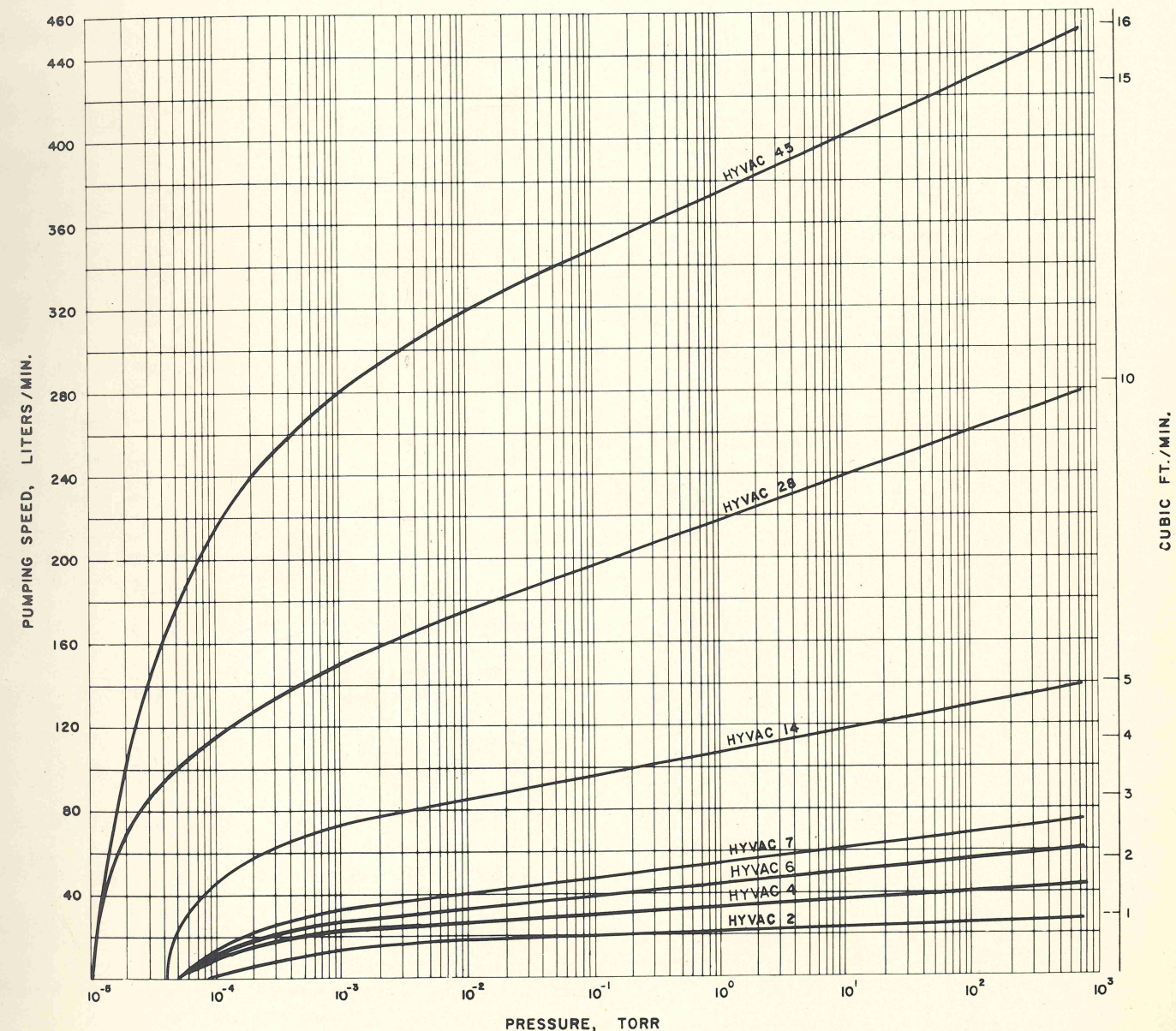


Fig. 2—Pumping speed and pressure characteristics of the Cenco Hyvac 2, 4, 6, 7, 14, 28, and 45 Pumps

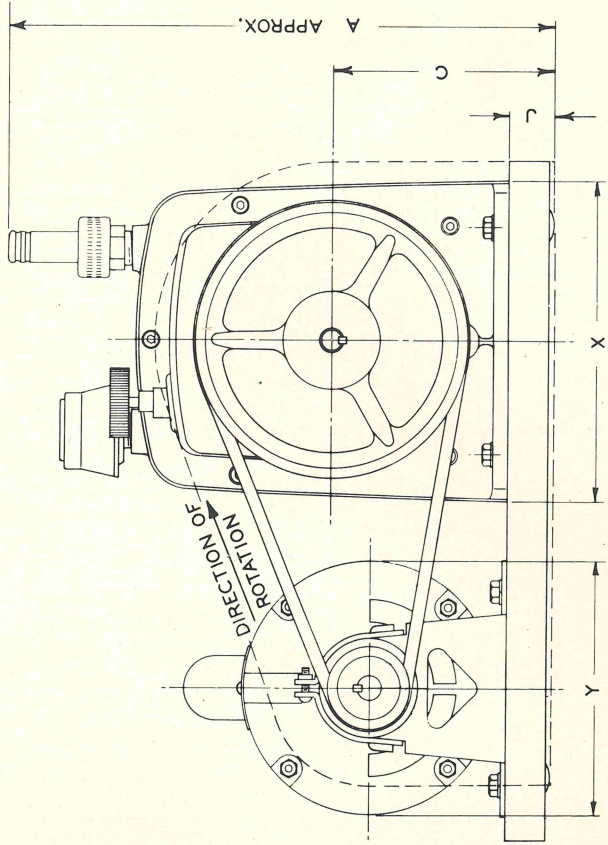
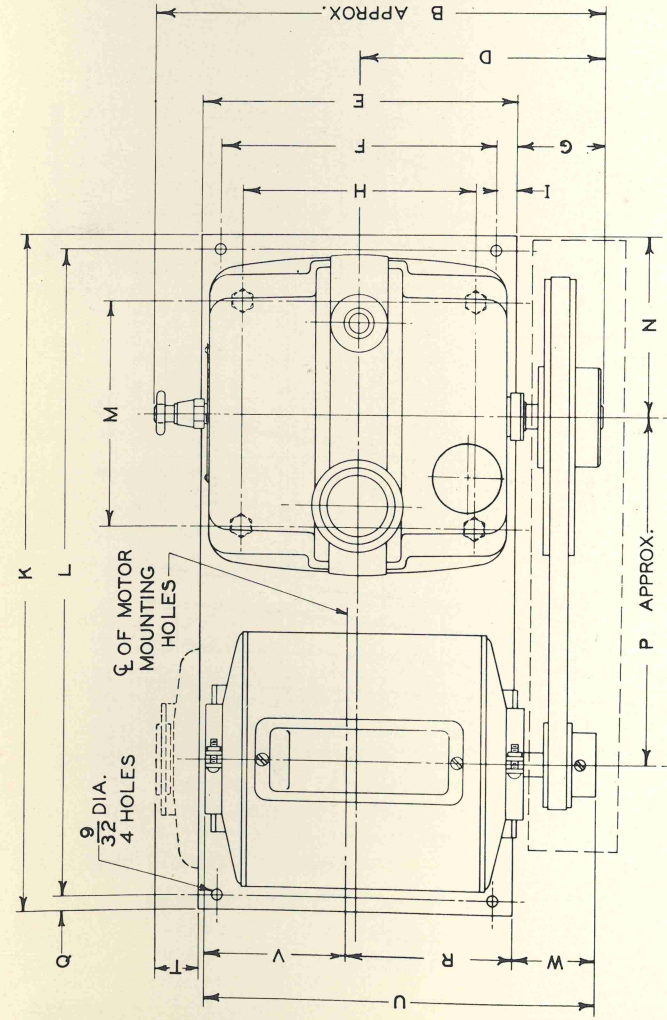
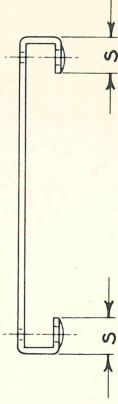


Fig. 3—Major dimensions of the Hyvac 2, 4, 6, 7, and 14 Pumps

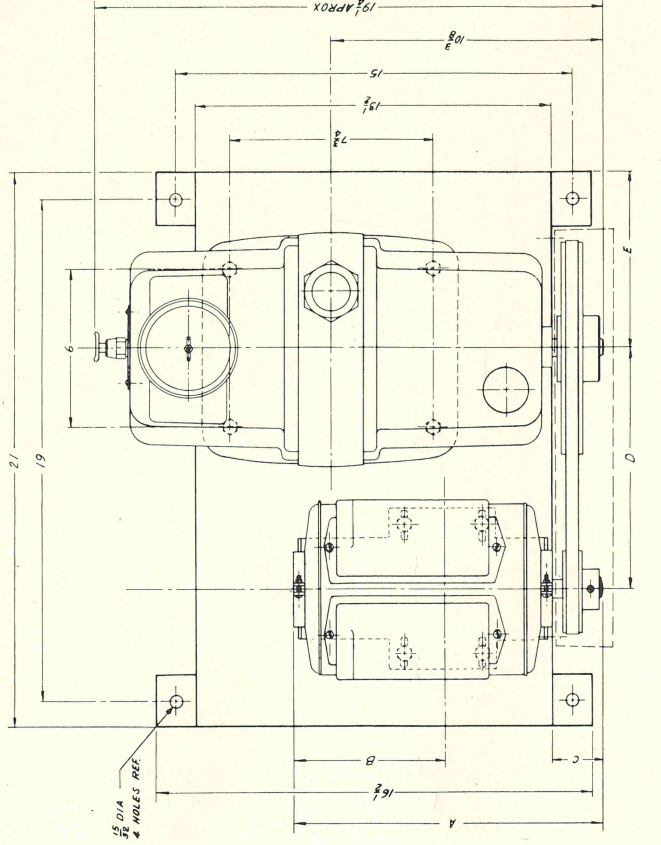
SIDE VIEW OF BASE



*THESE DIMENSIONS APPLY ALSO TO HYVAC 4 AND HYVAC 6.

ITEM	NO. 91305 HYVAC 2	NO. 91506 HYVAC 7	NO. 91705 HYVAC 14	NO. 91305, 91308			
	A	B	C	D	E	F	G
A	10 5/16	12 1/2	15 1/2	18 1/2	21 1/2	24 1/2	27 1/2
B	9 5/16	11 1/2	13 1/2	15 1/2	17 1/2	19 1/2	21 1/2
C	4 1/2	5 5/8	6 5/8	7 5/8	8 5/8	9 5/8	10 5/8
D	5 1/2	6 1/4	7 1/4	8 1/4	9 1/4	10 1/4	11 1/4
E	7	8 1/4	9 1/4	10 1/4	11 1/4	12 1/4	13 1/4
F	6	7 1/4	8 1/4	9 1/4	10 1/4	11 1/4	12 1/4
G	2 1/2	3 1/4	4 1/4	5 1/4	6 1/4	7 1/4	8 1/4
H	4 3/4	5 3/4	6 3/4	7 3/4	8 3/4	9 3/4	10 3/4
I	1 1/2	2 1/4	3 1/4	4 1/4	5 1/4	6 1/4	7 1/4
J	1 1/8	2 1/8	3 1/8	4 1/8	5 1/8	6 1/8	7 1/8
K	15	17 1/4	19 1/4	21 1/4	23 1/4	25 1/4	27 1/4
L	14 1/4	16 1/2	18 1/2	20 1/2	22 1/2	24 1/2	26 1/2
M	4 1/2	5 3/4	6 3/4	7 3/4	8 3/4	9 3/4	10 3/4
N	3 1/2	4 1/2	5 1/2	6 1/2	7 1/2	8 1/2	9 1/2
P	7 1/2	8 1/2	9 1/2	10 1/2	11 1/2	12 1/2	13 1/2
Q	3 3/8	4 3/8	5 3/8	6 3/8	7 3/8	8 3/8	9 3/8
R	3 25/32	4 25/32	5 25/32	6 25/32	7 25/32	8 25/32	9 25/32
S	7 7/8	8 7/8	9 7/8	10 7/8	11 7/8	12 7/8	13 7/8
X	6 9/16	7 9/16	8 9/16	9 9/16	10 9/16	11 9/16	12 9/16

HYVAC 45



HYVAC 28

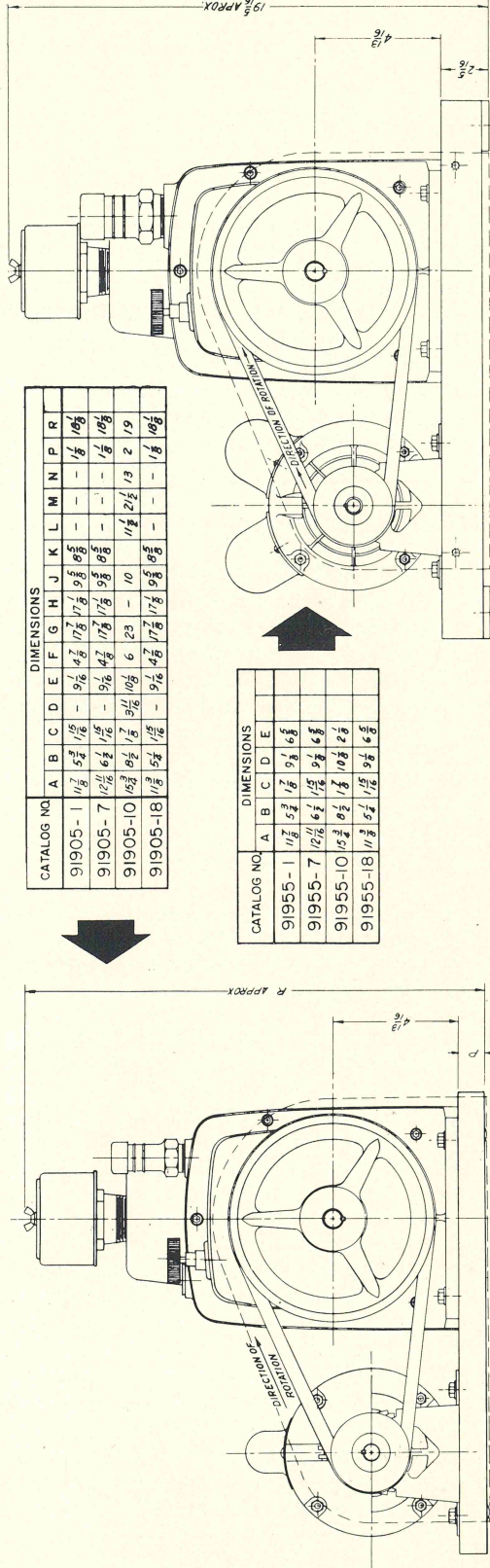
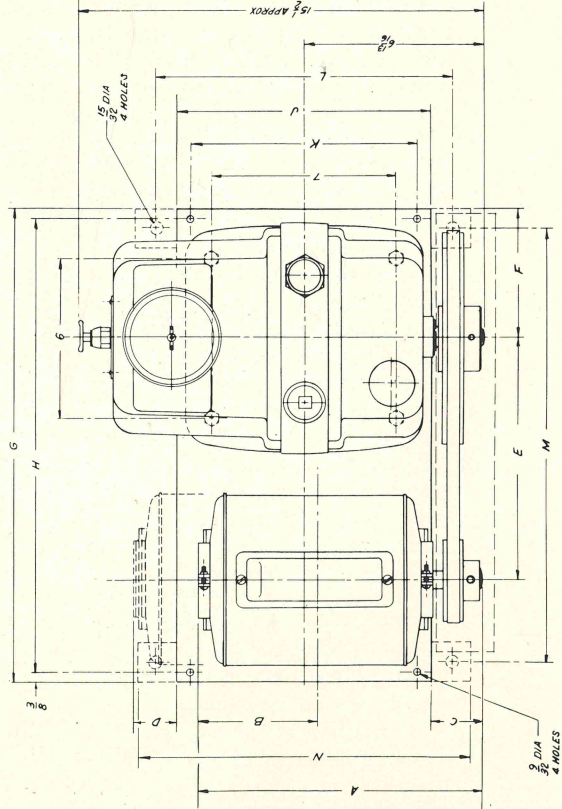
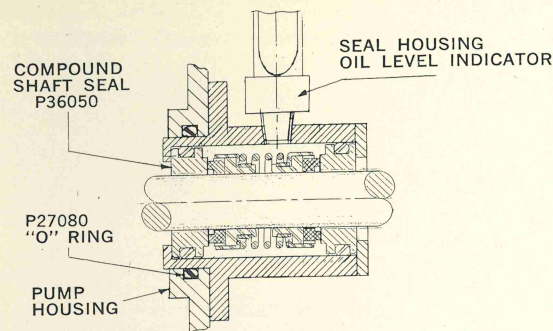


Fig. 4—Major dimensions of the Hyvac 28 (left) and Hyvac 45 Pumps



The above is a cross-section sketch of the compound shaft seal. The purpose of the compound seal is to prevent the passage of gas. The compound seal is made up of an inner seal and an outer seal, separated by a significant distance so that a chamber is formed. By maintaining a head of oil inside the chamber, a nearly zero differential pressure is created across the inner seal, thereby preventing the passage of gas. The outer seal maintains this oil head.

5 installation

5.1 Pump Mounting: Each mounted pump is shipped ready for immediate installation. An unmounted pump, however, first should be mounted on a flat, rigid, steel or cast-iron base, such as that supplied with the mounted unit. The major dimensions of the pump, pump base and motor are given in Figs. 3 and 4. Provisions should be made for bolting the base to the floor or, if the pump is to be used in a movable unit, to the frame. When electronic equipment is attached to the same frame, shock mounts should be installed so that vibrations from the motor or pump will not be transmitted through the frame.

A pump should be mounted perfectly level so the oil level can be read accurately. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump.

5.2 Motor Connections: Motors supplied with the Hyvac 2 (Cenco Nos. 91305-1 to -7 and 91308-1 to -7), Hyvac 4 (Cenco Nos. 91482-1 to -7), Hyvac 6 (Cenco Nos. 91492-1 to -7), and Hyvac 7 (Cenco No. 91506-1 to -7) have a connecting cord and a three-prong plug attached. All other pump assemblies require permanent connections. In all cases, connect the motor to a power line of the voltage, frequency and phase indicated on the nameplate of the motor. The power line should be heavy enough to carry the current required without causing any undue drop in voltage. All motors can be operated on across-the-line start.

Remember that fuses provide short-circuit protection only for the power supply line; they do not protect the motor from overload. For correct selection of the power-line fuse, consult Table II. A suitable starting switch with motor overload protection should be used for all permanent installations.

5.3 Vacuum Connections: The Hyvac 2, 28, and 45 pumps are provided with one-piece intake nipples which are intended primarily for use with rubber tubing. The Hyvac 4, 6, 7, and 14 pumps are provided with a vacuum coupling as illustrated in Fig. 6 and Fig. 8.

Table II
MOTOR ELECTRICAL DATA

Pump Model	Cenco Pump No.	Current at Full Load (Amperes)			Max. Fuse Rating (Amperes)		
		at 115V	at 230V	at 440V	at 115V	at 230V	at 440V
Hvac 2	91305-1 91308-1	4.4	2.2	...	...	...	...
	91305-7 91308-7	4.8	2.4	...	...	...	...
	91305-10 91308-10	4.4	2.2	...	...	...	...
	91305-18 91308-18	...	1.1	0.6	...	...	...
	...	...	...	...	...	...	...
Hvac 4	91482-1	5.6	2.8	...	20	...	...
	91482-7	6.2	3.1	...	25	...	...
	91482-10	5.6	2.8	...	20	15	15
	91482-18	...	1.6	0.8	...	...	...
	...	...	...	...	...	...	...
Hvac 6	91492-1	5.6	2.8	...	20	...	...
	91492-7	6.2	3.1	...	25	...	...
	91492-10	5.6	2.8	...	20	15	15
	91492-18	...	1.6	0.8	...	...	...
	...	...	...	...	...	...	...
Hvac 7	91506-1	5.6	2.8	...	20	...	...
	91506-7	6.2	3.1	...	25	...	...
	91506-10	5.6	2.8	...	20	15	15
	91506-18	...	1.6	0.8	...	...	...
	...	...	...	...	...	...	...
Hvac 14	91705-1	7.8	3.9	...	...	...	...
	91705-7	7.4	3.7	...	25	15	15
	91705-10	7.8	3.9	...	...	...	...
	91705-18	...	1.9	0.9	...	...	...
	...	...	...	...	...	...	...
Hvac 28	91905-1	13	6.5	...	...	...	...
	91905-7	12	6.0	...	30	15	15
	91905-10	13	6.5	...	...	...	...
	91905-18	...	3.6	1.8	...	...	...
	...	...	...	...	...	...	...
Hvac 45	91955-1	13	6.5	...	...	...	...
	91955-7	12	6.0	...	30	15	15
	91955-10	13	6.5	...	...	...	...
	91955-18	...	3.6	1.8	...	...	...
	...	...	...	...	...	...	...

It is recommended that the following procedure be observed before making any vacuum connections:

- (1) Remove the plastic protector from the hose nipple (or vacuum coupling).
- (2) Remove the plug from the exhaust port, and install the exhaust dome.
- (3) Remove the drain plug and install the drain cock.
- (4) When making glass connections between the pump intake nipple and the vacuum system, use a short rubber hose as a coupling between nipple and glass tube, and take extreme care to eliminate any source of leakage.
- (5) Make sure that both members of each connection are coated with vacuum stopcock grease and that all connections to metal or glass tubing fit snugly. It is best to solder or braze all metal connections.
- (6) If threaded pipe joints are used, the threads should be as perfect as possible. When making threaded connections, screw the members together a few turns, and then apply Glyptal to the exposed threads before screwing them tightly together. Allow the Glyptal to dry for several hours before starting the pump.
- (7) If flanged connections are used, install flat or "O" ring gaskets, made of rubber or Neoprene, between the flanges to prevent leakage. Place a thin coat of oil on the "O" ring before installation. Cenco No. 90020-25 Vacuum Seals may be used for intake flange connections.
- (8) Rubber tubing connections should be made with an extra-heavy-wall gum tubing, such as No. 18204, which has been compounded specially for vacuum work.
- (9) For maximum gas flow and minimum pressure drop, make all vacuum connections as short as possible, and use tubing of as large a diameter as possible.

The conductance of various sizes of tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008, or may be determined from Fig. 5, in which the quantity $(L + \frac{4}{3}D)$ is plotted against Z , the conductance in cubic centimeters per second. The symbols L and D represent the length and inside diameter of the tubes in centimeters. The average pumping speed of the system, then, may be found by solving the following relationship:

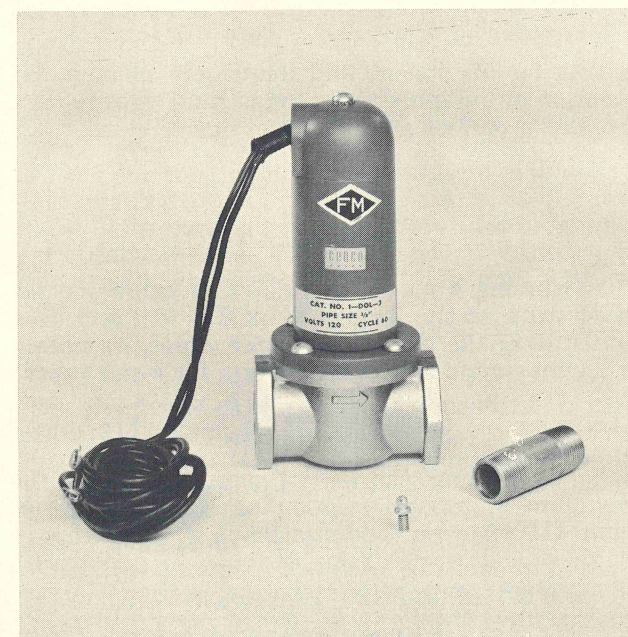
$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pumping speed, taken from Fig. 2, and Z is the conductance of all the tubing or the connecting line between the pump and the system. The time required to evacuate a vessel of volume V is given by the formula:

$$T = \frac{2.3V}{S} \cdot K$$

where T is the time in seconds, V the volume of the vacuum system expressed in liters, and S the average pumping speed expressed in liters per second, for operation from atmospheric to final pressure. The factor K has values of 4, 5, and 6. The value 4 is used for a final pressure of 100 millitorr, 5 for 10 millitorr, and 6 for 1 millitorr.

5.4 Valve Connections: Generally, metal vacuum valves and glass stopcocks are employed in the connecting line between the pump and the system for connecting the vacuum gage and for releasing the vacuum system after pumping has been terminated. When metal tubing is used, a high-vacuum valve, such as No. 94551 or 94280, is recommended.

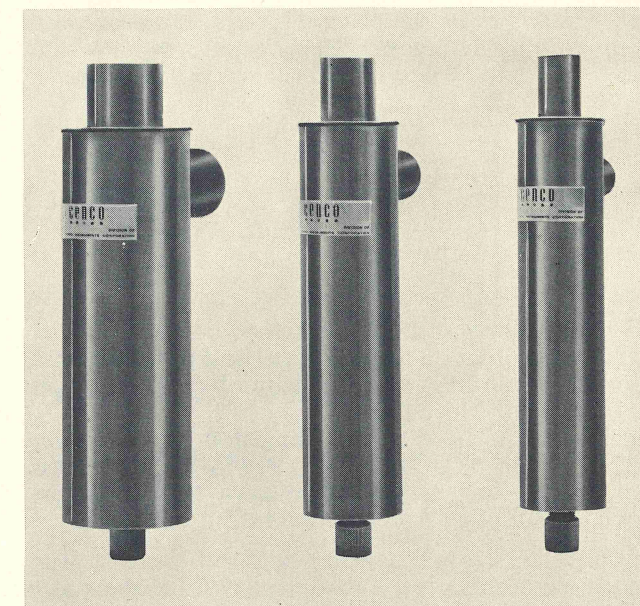


Low-Pressure Solenoid Valve, Cenco No. 94280

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of leak-testing the pump and the system by the pressure-rise method without disconnecting the pump from the line.

5.5 Vacuum-System Traps: Extreme care must be taken to prevent solid particles from reaching the intake of the pump, otherwise they will score the working parts of the pump and reduce its efficiency. If corrosive vapors are present in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor (from the pump) from entering the system.

A Cenco No. 94009 Liquid Nitrogen Trap is recommended for this purpose. For detailed specifications on the traps, refer to Section 8, Accessories.



Liquid Nitrogen Traps, Cenco No. 94009

If large amounts of water vapor are pumped and a large ballast flow is used, some oil mist will be discharged with the ballast air and vapor. It is a good hygienic practice to pipe the exhaust outside the work area. For this purpose, remove the filter dome and connect a 3-inch IPS pipe directly to the exhaust outlet. For best performance, a simple condensing trap should be provided in the exhaust line as close to the pump as possible to prevent the condensate, which will form in the pipe, from running back into the pump.

5.6 Gages: The types of high vacuum gages commonly used in a system employing a Hyvac pump are the McLeod, Pirani, discharge, and thermocouple gages.

A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 mm Hg to 1.6 mm Hg (0.5 to 1600 millitorr). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint.

The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 millitorr and from 1 to 50 millitorr.

The Thermocouple gage permits pressure measurements in the range from 1 to 1000 millitorr.

The Discharge gage operates within the range of 0.001 to 20 millitorr.

All vacuum gages are illustrated and described in Section 8, Accessories.

5.7 Oil Requirements: Each Hyvac Pump is shipped with the oil drained from the reservoir. Oil is supplied for the first filling and for periodic oil changes. To fill the pump with oil, remove the exhaust dome and pour oil through the opening up to the oil level sight gage. Turn the pump pulley several revolutions by hand while filling the pump with oil. The oil level window indicates the correct oil level. If insufficient oil is used, a good seal around the vanes may not be maintained. *If too much oil is used, oil may back up through the pump trap and into the vacuum system.*

Pump Model	Oil supplied with pump, Pints	Oil required for one filling, Pints
Hyvac 2	3	2
Hyvac 4	4	3
Hyvac 6	4	3
Hyvac 7	4	3
Hyvac 14	8	5
Hyvac 28	8	7
Hyvac 45	10	9

5.8 Belt Guard: Cenco-designed belt guards furnish ideal protection for personnel and pump against damages which may be caused by objects falling on the belt or into the pulley. Except for the base on the explosion-proof version of the Hyvac 45, Cenco No. 91955-10, all Cenco pump bases are drilled to receive these guards, which are supplied ready for mounting.

6 operation

6.1 Starting up the Pump: When a large rotary vacuum pump is turned off without being let up to atmosphere on its intake side, oil, driven by atmospheric pressure, begins to fill the volume between stator and rotor. Because the pump and its valves are designed to handle compressible gas, not incompressible oil, sometimes the electric motor cannot turn the rotor over against the resistance of oil-filled passages. To prevent this difficulty, never leave a pump turned off for more than a few minutes while it is still connected to a vacuum. *If the pump has been properly installed, it will begin to pump immediately each time the motor is turned on.*

NOTE: Oil shooting from the exhaust dome of an operating pump indicates that the pump contains too much oil. If this happens, stop the pump and drain oil slowly until the oil level is at the proper height. It is good vacuum practice to take an occasional check of the oil level while the pump is running.

For Pump Nos. 91301 and 91501 only: A small leak through the inner seal of the compound seal is permitted as long as oil flows into the pump. This may be observed when the level of oil in the seal housing oil indicator drops. At the same time there should be no oil dripping from the housing or the outer shaft seal. If the leakage is great enough to affect the oil level or to cause oil to drip out copiously, the seal should be replaced. See Section 7.4 for Seal Replacement.

6.2 Gas Ballast: The gas ballast pump is ideally suited for pumping all vapors which do not chemically attack or dissolve in the pump oil; water is a typical example. Even after contamination of the oil has occurred, the gas ballast pump is able to purify the oil if the system is temporarily shut off from the pump and the pump is kept running for a suitable length of time. The contaminated oil will continually circulate from the oil supply channel into the high vacuum side, where the contaminant will evolve as vapor. This vapor then will be discharged with the ballast air as described before, until eventually all the contaminant has been expelled. For this reason, the oil of pumps employing the gas ballast does not have to be changed as often as the oil of pumps which do not have the gas ballast. Although it is impossible to calibrate the gas ballast control for all pumps at all operating pressures, it is useful to know the effectiveness of different gas ballast flow rates on the pumping of vapors. The following formula will enable the user to calculate the maximum pumping rate of insoluble vapors without their contaminating the pump oil:

$$W = DV \cdot \frac{P_a}{P_e - P_s} \cdot \frac{T_p}{T_a} \text{ (g/min)}$$

where:

T_p = pump temperature ($^{\circ}\text{K}$) (taken as pump oil temperature)

T_a = ambient temperature ($^{\circ}\text{K}$)

P_a = barometric pressure (torr)

P_s = saturation pressure of pumped vapor at pump temperature T_p (torr)

P_e = pressure under pump exhaust valve at instant of exhausting (torr)

V = rate of dry gas ballast flow at atmospheric pressure P_a (lit/min)

D = density of pumped vapor at temperature T_p and pressure P_s (g/lit)

W = maximum safe mass rate for pumping vapors (g/min)

Solving for the special and frequently encountered situation of pumping water vapor, and treating this vapor as a perfect gas so that at exit

$$D_{\text{water vapor}} = \frac{18}{22.4} \cdot \frac{P_s}{760} \cdot \frac{273}{T_p} \\ = 0.289 \frac{P_s}{T_p} \text{ (g/l)}$$

and assuming a pressure of 850 torr below the exhaust valve at the instant of exhaustion, and then substituting the density of water vapor, we obtain as the maximum safe pumping rate for water vapor:

$$W_{\text{water vapor}} = 0.289 \left(\frac{V}{T_a} \right) \left(\frac{P_a P_s}{850 - P_s} \right) \text{ (g/min)}$$

Using 10 lit/min gas ballast flow, we obtain the maximum water-vapor pumping rates shown in Table III when no condensation is in the pump:

Table III
WATER-VAPOR PUMPING RATES

Pump Temperature in $^{\circ}\text{C}$	Maximum Water-Vapor Pumping Rate in g/min	
	With zero humidity in gas ballast air	With 100% humidity in gas ballast air
50	0.91	0.72
60	1.60	1.39
70	2.84	2.59
80	5.38	5.08

For above data

$$P_a = 760 \text{ torr} \quad T_a = 20^{\circ}\text{C} = 293^{\circ}\text{K}$$

The gas ballast flow can be adjusted by turning the gas ballast valve, located near the exhaust filter dome.

If the ultimate vacuum of the pump is not required, it is possible to obtain almost noiseless operation by "cracking" open the gas ballast valve. The ultimate pressure which can be obtained in this instance is approximately 30 millitorr.

7 maintenance

7.1 General: The maintenance requirements of the Cenco Hyvac Pump vary with application. Proper lubrication is one of the most important factors in securing reliable performance (See Paragraph 7.2).

If a pump is connected into a normal leak-free system, there should be no malfunction that might not be remedied by simple adjustments. If a pump fails to function, the cause usually can be attributed to a minor mechanical failure such as a broken spring, a sticking vane, or worn valve release, rather than to misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal operation, where no corrosive vapors are encountered, there will be no decrease in the efficiency of a pump over a period of several years.

7.2 Oil Change: A decrease in the value of maximum vacuum attainable is usually an indication that the oil has become contaminated. Oil should be changed at the first sign of contamination.

To remove the oil, stop the pump, place a large receptacle underneath the drain, and open the drain cock. Turn the shaft several revolutions to force out any remaining oil. Flush with clean Flushing Oil, No. 93060, at least once and then refill with new Hyvac Oil No. 93050.

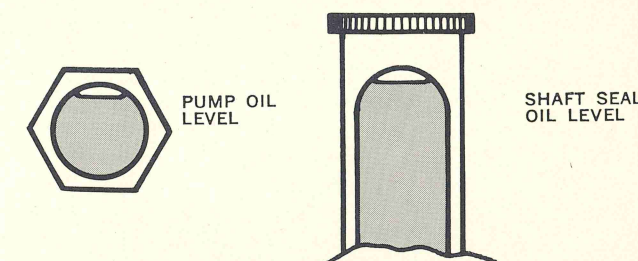
The frequency of oil change is dependent upon the use of the pump. An oil change may be needed only once in six months if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosive or highly condensable vapors enter the pump.

When the pump is operated continuously, the oil temperature may reach 50° to 60°C . This temperature is normal for efficient operation of the pump.

7.3 Belt Adjustment: The belt in mounted pumps can be adjusted by loosening the bolts in the base of the motor and moving the motor in the required direction. The belt should be just tight enough to prevent slippage while operating. A little slippage on starting is desirable.

7.4 Shaft Seal Replacement: The seal on the pump shaft, symbol 21 in Fig. 8, consists of a "Truarc" ring, (7), a thrust washer (26), a shaft seal (9), and an "O" ring, (4). Remove the "Truarc" ring, the thrust washer, the shaft seal, and finally the "O" ring, in this order.

Before assembling or making a replacement, apply a thin film of pump oil to the pump shaft. Also apply the same amount of oil to the inner surface of the shaft seal. Replace the shaft seal carefully so as not to damage the inner surface of the rubber seal ring. Push the seal back into the cavity until it contacts the "O" ring. Replace the thrust washer, and force the washer and spring over the groove in the shaft. Finally, replace the "Truarc" ring.



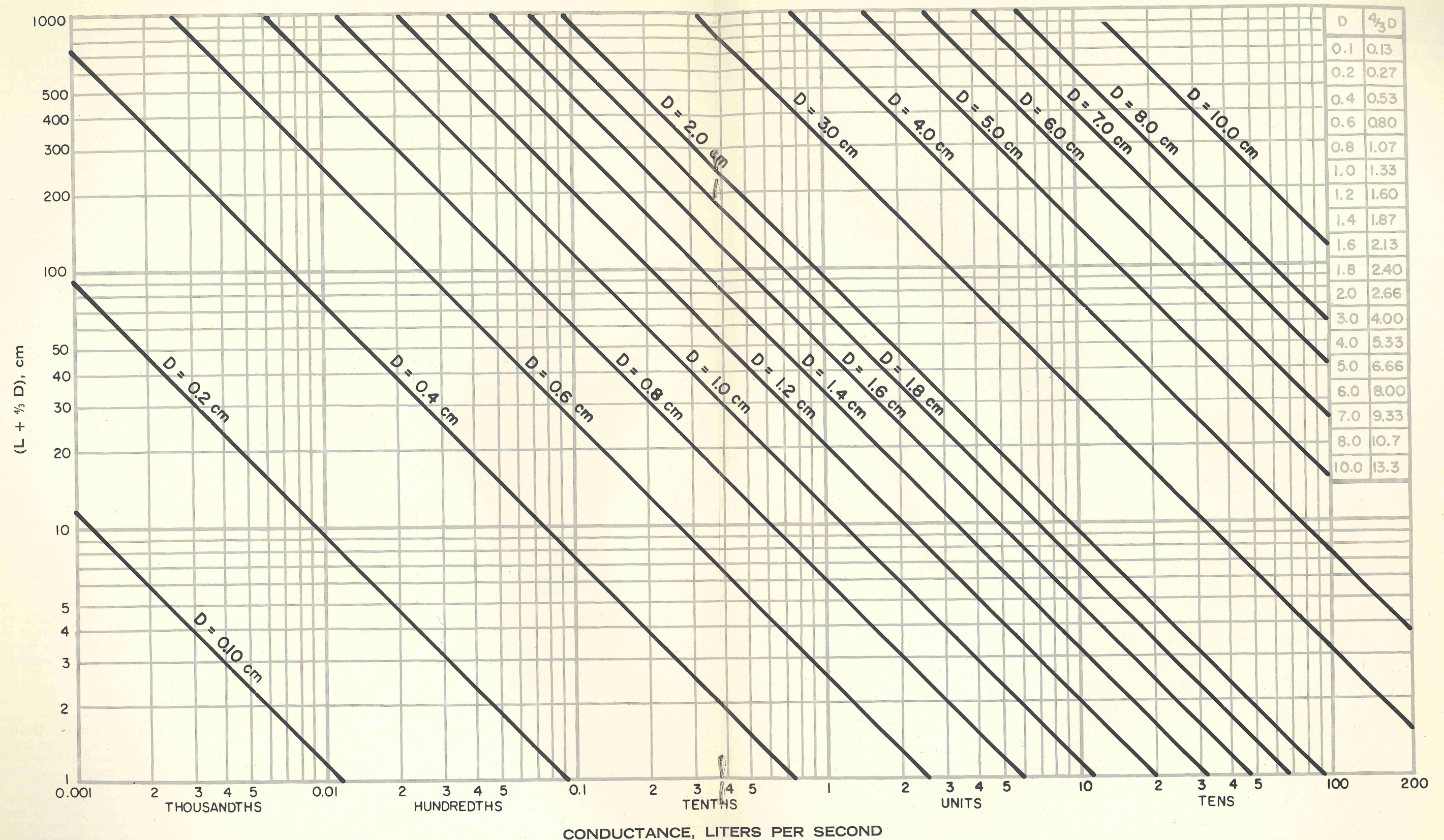
For Pump Nos. 91301 and 91501 Only: Leakage by the inner shaft seal is detected obviously by a change of oil level in the oil level indicator. If this change is small, it can be ignored. If great, it is a sign that the inner seal should be changed. Leakage by the outer seal is detected clearly by the presence of dripping oil. If small, it can be ignored. If great, the seal should be replaced. Leakage between the pump housing and seal housing requires changing of the Cenco No. P27080 "O" Ring.

7.5 Repairs: Fig. 8 shows cross sectional views of the Hyvac Pump. Figs. 6 and 7 show a disassembled view of the pump and all its components. Section 7.6 lists the part number for each component of the pump. When ordering replacement parts, please give the exact part number. For repairs to the pump other than the replacement of the shaft seal, it is strongly recommended that the pump be returned to the factory, especially when adequate shop facilities are not available.

If operated according to instructions, any Hyvac pump will provide years of satisfactory service. If trouble develops, turn off the pump at once. Only a qualified technician who has available the finest machine shop facilities should attempt to service the pump, using the drawings and charts provided. If the difficulty cannot be corrected immediately, contact your nearest Cenco Branch office or the Service Department, giving all symptoms of the malfunction and wait for further instructions. *Do not return the pump or any of its components without written authorization from Cenco.*

The techniques used in the manufacture of Cenco pumps assure interchangeability of parts from pump to pump and eliminate the need for selective parts fitting. Parts are stocked in Cenco's coast-to-coast warehouse system and are immediately available to users everywhere. In addition, Cenco offers regular factory repair service at its main plant.

Fig. 5—Relationship between tubing dimensions and tubing conductance



TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently, the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain a pumping speed (S) as large as possible, the tube conductance (Z) must be very large when compared with the speed of the pump (S_1). This is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} S_1$$

Since at best S is only a fraction of S_1 , the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance (Z), shown in liters/sec., is plotted as abscissas against the quantity $(L + \frac{4}{3}D)$ in cm, as ordinates. In addition to the parameter D , the value of $\frac{4}{3}D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm long, having a diameter of 2 cm, is required. As it can be seen from the table, for $D = 2$, the value of $\frac{4}{3}D = 2.66$ cm. Referring to the curve, for $D = 2$ the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines spaced logarithmically, conductance of tubes having diameters other than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely $\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$ where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

7.6 Replacement Parts: For the convenience of those who wish to replace any component of the Hyvac Pumps described in this booklet, the parts

herein listed are keyed to the identifying symbols used in Figs. 6, 7, and 8. For prices of the replacement parts, consult Section 10.

SYMBOL	PART NAME	NUMBER REQUIRED PER PUMP	PART NUMBER							
			Hyvac 2	Hyvac 4	Hyvac 6	Hyvac 7	Hyvac 14	Hyvac 28	Hyvac 45	
1	Drain Cock	1	P13116	P13116	P13116	P13116	P13116	P13116	P13116	
2	Exhaust Dome	1	P35352	P35345	P35345	P35345	P35341	P35617	P35617	
3	Direction Plate	1	P25220	P25252	P25252	P25252	P25212	P25329	P25348	
4	"O" Ring, Shaft Seal	1	P27080	P27080	P27080	P27080	P27082	P27082	P27082	
5	Vane Spring	2	P28066	P28065	P28065	P28065	P28064	P28064	P28064	
6	Shaft Key	3	P29313	P29313	P29313	P29313	P29313	P29313	P29313	
7	Crescent Truarc Ring	3	P29260	P29260	P29260	P29260	P29187	P29187	P29187	
8	Oil Level	1	P35291	P35291	P35291	P35291	P35291	P35291	P35291	
9	Shaft Seal	1	P35332 ¹	P35332 ¹	P35332 ¹	P35332 ¹	P35334 ²	P35334 ²	P35334 ²	
10	Housing Gasket	2	91310-2	91310-7	91310-7	91310-7	91310-14	91310-14	91310-14	
11	Valve Limiter	1	P60827	P61018	P61018	P61018	P61018	P61018	P61018	
12	Exhaust Vane	2	P60787	P60776	P60776	P60776	P60765	P60765	P60765	
13	Exhaust Rotor	1	P60788	P60777	P60777	P60777	P60766	P60766	P60766	
14	Exhaust End Plate	1	P60789	P60778	P60778	P60778	P60767	P60767	P60767	
15	Exhaust Stator	1	P60790	P60779	P60779	P60779	P60768	P60768	P60768	
16	Intake End Plate	1	P60791	P60780	P60780	P60780	P60769	P60769	P61143	
17	Intake Stator	1	P60792	P60781	P60781	P60781	P60770	P60770	P60770	
18	Center Plate	1	P60793	P60782	P60782	P60782	P60771	P61131	P61151	
19	Drain Housing	1	P60794	P60783	P60783	P60783	P60772	P61118	P61118	
20	Seal Housing	1	P60795	P60784	P60784	P60784	P60773	P60773	P61150	
21	Shaft	1	P60797	P60786	P60786	P60786	P60775	P61129	P61144	
22	Vacuum Coupling Nut	1	---	P63516	P63516	P63516	P63519	---	---	
23	Spring Pin	2	P63503	P63501	P63501	P63501	P63499	P63499	P63499	
24	Flutter Valve	1	P65471	P65470	P65470	P65470	P65532	P65532	P65532	
25	Coupling Adapter	1	---	P63545	P63545	P63545	P63546	---	---	
26	Thrust Washer	1	P78031	P78031	P78031	P78031	P78032	P78032	P78032	
27	Thrust Washer	2	P78034	P78034	P78034	P78034	P78033	P78033	P78033	
28	1/4-20 x 2-1/4 Hex. Hd. Steel Screw	10	P29315	---	---	---	---	---	---	
28	1/4-20 x 3 Hex.Hd.Steel Screw	10	---	P29316	P29316	P29316	---	---	---	
28	5/16-18 x 3-1/2 Hex.Hd.Steel Screw	10	---	---	---	---	P29317	P29317 ³	---	
29	1/4-20 x 3/4 Soc. Hd. Steel Screw	10	---	---	---	---	---	---	---	
29	5/16-18 x 1 Soc. Hd. Steel Screw	14	---	---	---	---	---	---	---	
30	1/4-20 x 1 Soc. Hd. Steel Screw	4	---	---	---	---	---	---	---	
30	1/4-20 x 1-3/4 Soc. Hd. Steel Screw	4	---	---	---	---	---	---	---	
30	5/16-18 x 2 Soc. Hd. Steel Screw	8	---	---	---	---	---	---	---	
31	No. 2 x 5/16 Rd. Hd. Drive Screw	4	---	---	---	---	---	---	---	
32	10-24 x 1/4 Rd. Hd. Steel Screw	2	---	---	---	---	---	---	---	
33	No. 10 Bright Steel Burr	1	---	---	---	---	---	---	---	
34	No. 10 Split Lock Washer	1	---	---	---	---	---	---	---	
35	Intake Vane	2	P60787	P60776	P60776	P60776	P60765	P60765	P60765	
36	Intake Rotor	1	P60788	P60777	P60777	P60777	P60766	P60766	P60766	
37	"O" Ring, Coupling	1	---	94236-4	94236-4	94236-4	94236-5	---	---	
38	Intake Screen	1	P29295	P29296	P29296	P29296	P29297	P29492	P29513	
39	Coupling Hose Nipple	1	---	P63556	P63556	P63556	P63558	---	---	
40	Hose Nipple	1	P69263	---	---	---	---	P63764	P63765	
43	Gas Ballast Valve	1	P67416	P67416	P67416	P67416	P67416	P67416	P67416	
44	Gas Ballast Valve Knob	1	P26139	P26139	P26139	P26139	P26139	P26139	P26139	
45	Belt	1	P27185 ⁴	P27113	P27114 ⁵	P27114 ⁵	P27113	P27113	P27113	
46	Valve Limiter	3	---	P61108	P61108	P61108	P61108	P61108	P61108	
47	5/16-18 x 6-1/4 Hex. Hd. Stl.Cap Screw	5	---	---	---	---	---	P29553	P29553	
48	Gas Ballast Grommet	1	P27120	P27120	P27120	P27120	P27120	P27120	P27120	
49	Relief Valve Ball	3	---	P29012	P29012	P29012	P29514	P29514	P29514	
50	Intermediate Plate	1	---	---	---	---	---	P61119	P61153	
51	Exhaust Side Intermediate Plate No. 1	1	---	---	---	---	---	---	P61148	
52	Exhaust Side Intermediate Plate No. 2	1	---	---	---	---	---	---	P61149	
53	Exhaust Side Intake Stator	1	---	---	---	---	---	---	P61152	
54	Pump Pulley	1	P35460	P29559	P29491	P29491	P29273	P29273	P29273	
55	Transfer	1	P35239	P35239	P35239	P35239	P35239	P35239	P35239	
56	Exhaust Baffle	1	---	---	---	---	P65767	---	---	
57	5/16-18 x 6-1/2 Hex. Hd.Stl.Cap Screw	5	---	---	---	---	---	---	P29458	

All items are illustrated except those numbered higher than 40 in the upper photo and Nos. 45, 54, 55, and 56 in the lower photo.

¹Replacement for Shaft Seal No. P35332 only:
Floating Seat Back-up Ring No. P27205
"O" Ring No. P27080

²Replacement for Shaft Seal No. P35334 only:
Floating Seat Back-up Ring No. P27206
"O" Ring No. P27082

³Hyvac 28 requires only 5 screws No. P29317

⁴Belt No. P27111 is used on pumps Serial No. 4000 to 3001

⁵Belt No. P27112 is used on pumps below Serial No. 3000

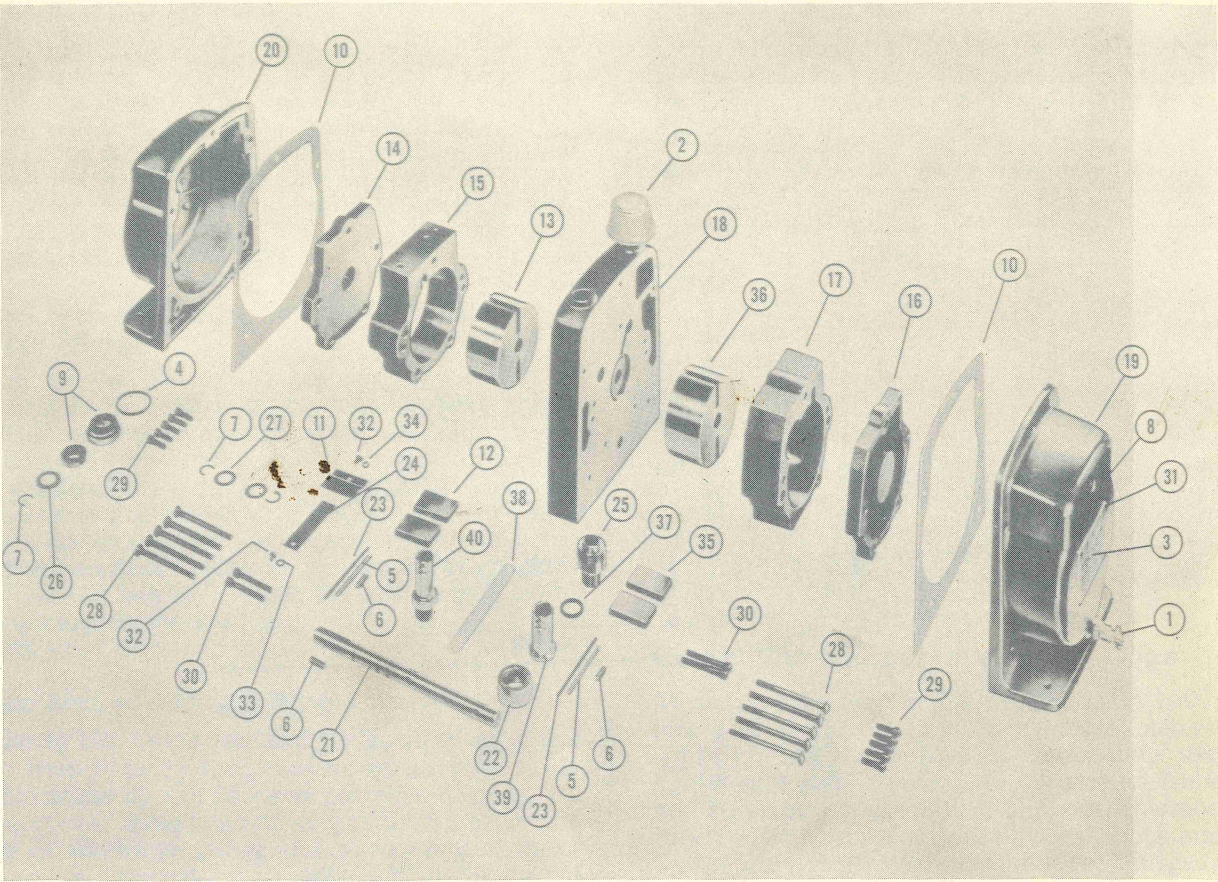


Fig. 6—View of the Hyvac 2, 4, 6, 7, and 14 Pumps disassembled.

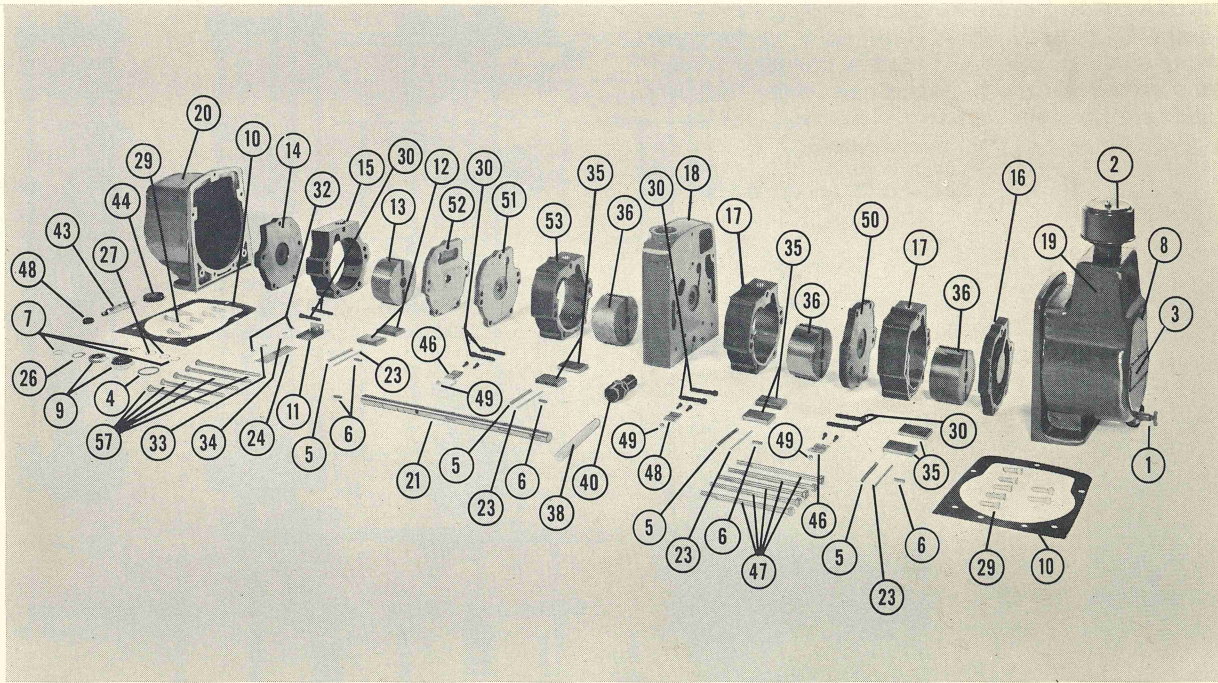


Fig. 7—View of the Hyvac 45 Pump disassembled

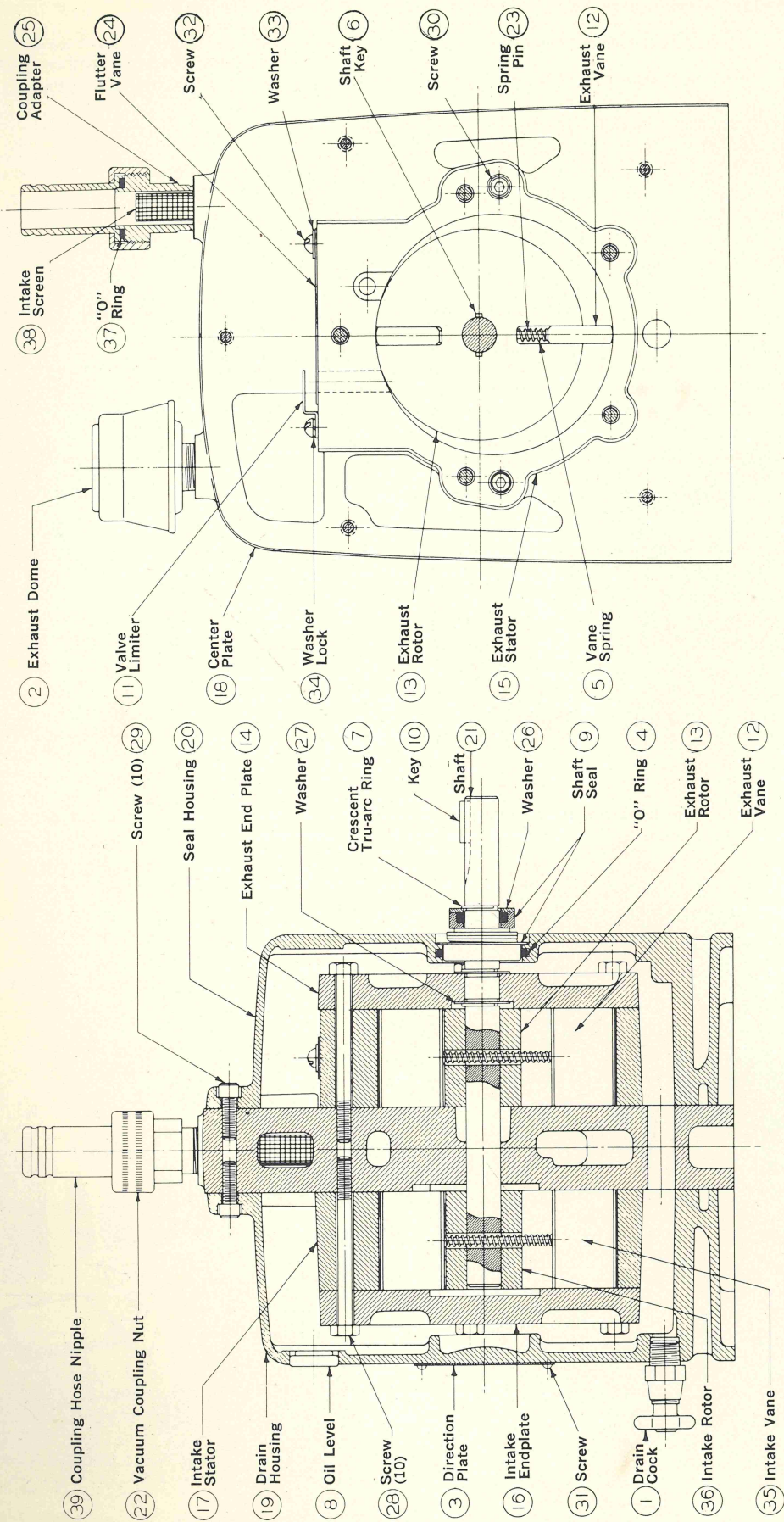


Fig. 8—Sectional view of the Hyvac 2, 4, 6, 7, and 14 Pumps

8 accessories

Cenco McLeod Gage, Double Range

For all measurements of pressure from 0.5 millitorr to 1600 millitorr. One range reads in millitorr from 0.5 to about 200 or 250; the other to about 1.6 torr. Over-all height is 165 cm. The amount of mercury required is about 10 pounds. Weight, without mercury, 30 pounds.

No. 94151, without mercury

\$205.00

Cenco McLeod Gage, Improved Design Double Range

Similar to the No. 94151 but for pressures from about 0.005 to 1000 millitorr. Double range, with one scale reading to approximately 25 millitorr and the other to approximately 1000 millitorr. This gage is intended for use in a system being exhausted by means of a diffusion or a molecular pump. It is made with replaceable precision-bore tubing. This gage requires about 30 pounds of mercury for operation. Over-all height is about 190 cm; weight, without mercury, is about 45 lbs.

No. 94156, without mercury

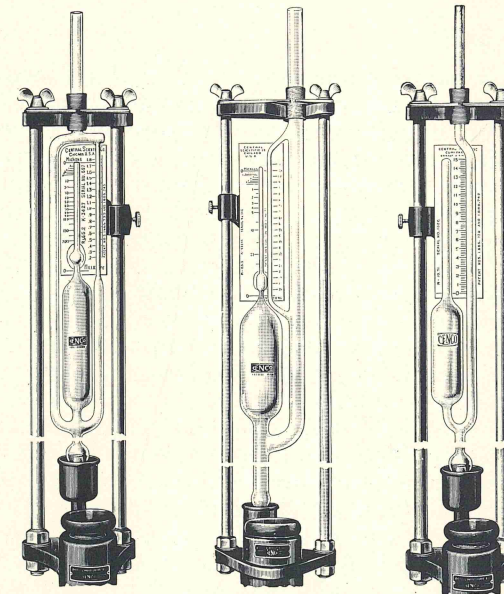
\$285.00

Cenco McLeod Gage, Single Range

Similar to No. 94151 McLeod Gage, but with single range from 0 to 15 torr, reading to 0.1 torr. Scale magnification by the McLeod principle is about 10. For accurate measurement of gas pressures in the filling of discharge tubes and in measurements of pressure in industrial processes. About 10 lbs. of mercury are required.

No. 94160, without mercury

\$170.50



94151

94156

94160

Cenco measuring heads for the 94151, 94156, and 94160 McLeod Gages.

Cenco Mercury for McLeod Gages

CP, ACS, Triple distilled quicksilver, Cenco No. 38116.

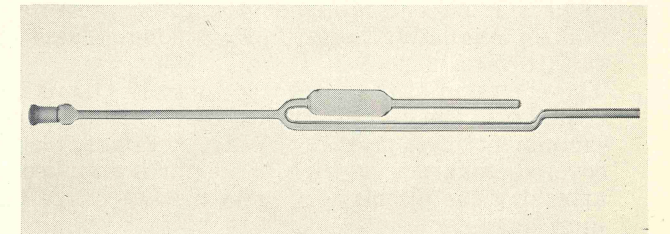
1 pound, bottle \$21.00 5 pound, bottle \$95.00

15 pounds maximum quantity for parcel post shipment.

McLeod Gage Glassware

Extra glassware for Nos. 94151, 94156 and 94160 Cenco McLeod Gages. Consists of calibrated glass head with interchangeable ground joint and a calibrated scale.

Cenco No.	McLeod Gage No.	O.D. Connecting Tube	Each
94165-3	94160	10 mm	\$67.50
94165-4	94156	18-19 mm	88.00
94165-5	94151	10 mm	88.00

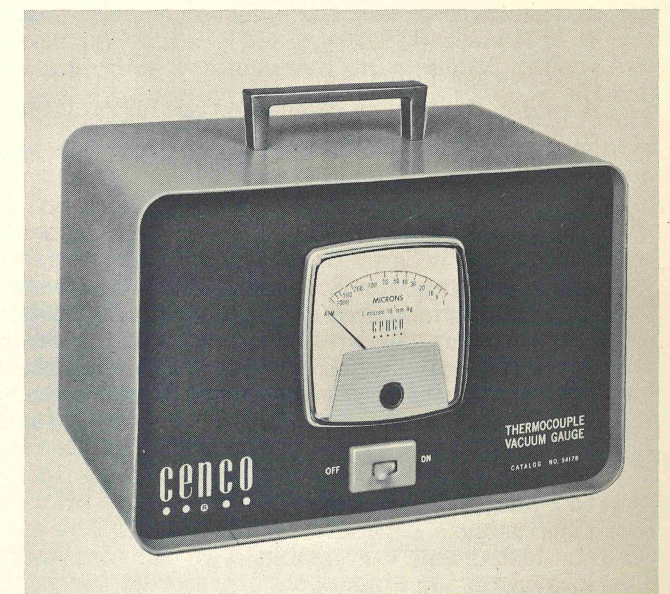


Cenco Thermocouple Vacuum Gage

Measures pressures in the range of 1 to 1000 millitorr and reads directly on a single meter scale. Adjusted and calibrated for immediate use, this lightweight gage responds to both condensable and non-condensable gases. The all-metal thermocouple tube resists contamination, physical shock and may be operated at atmospheric pressure. The gage tube has a standard 1/8" NPT male thread, is 5 1/4" long and 1" in diameter. A 5-foot, plastic covered, 4-wire cable with octal socket is supplied for connecting the thermocouple tube to the Thermocouple Gage supply. A separate meter is not required for the heater current. A constant voltage transformer accommodates line voltage variations. The unit is 10 1/4" long, 6 1/2" high and 5 1/2" deep. Attractively finished in blue and beige enamel. Available for operation from either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Supplied with a 3-wire cord and plug for positive electrical connections. Shipping weight is 12 pounds.

No. 94178-1, 115 volt, 60 cycle, ac
No. 94178-8, 230 volt, 50 cycle, ac

\$149.50
169.50



Cenco Discharge Gage

Continuous and direct pressure readings from all condensable vapors and permanent gases present in a vacuum system are indicated on a single meter scale. Measures vacuum continuously from 0.001 millitorr to 20 millitorr. The calibration is standardized with a McLeod Gage using dry air. The Discharge Vacuum Gage includes a transistorized dc amplifier and relay to operate auxiliary equipment such as pumps, heaters, etc., at any desired pressure on the scale. Both normally-open and normally-closed contacts are provided through banana jacks on the front panel, permitting the apparatus to be started and stopped at a given pressure. A built-in regulating transformer accommodates line voltage variations.

The open end of the discharge tube, 1" OD, is connected into the vacuum system by means of suitable vacuum fittings, gage ports, etc. A 6-foot, plastic-covered, coaxial wire with connector is supplied for attaching the discharge tube to the Discharge Vacuum Gage.



The Discharge Gage is 16 1/4" long, 7 1/2" high and 6 3/4" deep. Attractively finished in blue and beige enamel. Available for either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Relay contacts are rated for 1 ampere. For heavier loads, a No. 99720-1 or 99725 relay may be used. Supplied with a 3-wire line cord and plug for ground connections. Shipping weight is 15 pounds.

No. 94183-1, 115 volt, 60 cycle, ac \$295.00
No. 94183-8, 230 volt, 50 cycle, ac 325.00

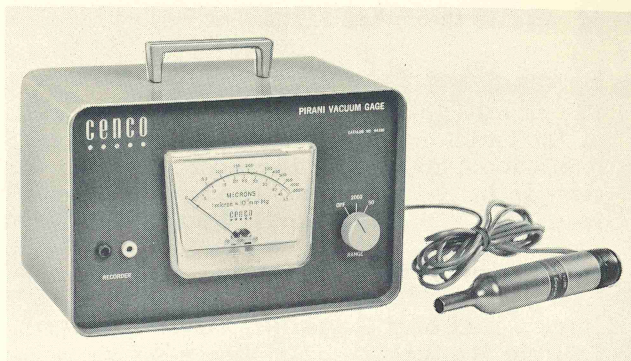
Discharge Tube

A cold-cathode glow-discharge type for replacement in No. 94183 Discharge Gage.

No. 94187 \$49.50

Cenco Pirani Gage

The Cenco Pirani Vacuum Gage, a thermal conductivity type, is based on the temperature and/or resistance change of a heated filament. This change or unbalance is measured on a conventional wheatstone bridge circuit. One arm of the bridge utilizes a compensating tube, sealed under vacuum, to make the circuit insensitive to ambient temperature changes. Pressure is continuously read on a meter having two scales calibrated to the bridge unbalance. One range is 0 to 50 x 10⁻³ torr, and the other is 50 x 10⁻³ torr to 2 torr. The power supply is a full wave bridge rectifier using a constant voltage source. This makes the instrument very stable. Two banana jacks are located on the front panel for recorder use.



Zero drift, which can be a serious problem in Pirani Gages, has been corrected to a great extent by operation of a filament at a much lower temperature (a maximum of 250° C. at a pressure well below 1.0 millitorr) and by inorganic treatment of the filament to provide a stable, inorganic, black surface. The Pirani tube is 7" long with an envelope OD of 1 1/4" and a tubulation OD of 1/2". The Cenco Pirani Vacuum Gage is 10 1/4" long, 6 1/2" high, and 5 1/2" deep. Attractively finished in blue and beige enamel, it is available for 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. The power consumption is 12 watts. Net weight is 8 pounds.

No. 94190-1, 115 volt, 60 cycle, ac \$189.00
No. 94190-8, 230 volt, 50 cycle, ac 197.50

Cenco Ionization Gage

This excellent Ionization Gage incorporates a wide range electrometer amplifier and is designed for use with Bayard-Alpert inverted ionization gage tubes. With it, dry air pressure measurements can be made in the range from 1 x 10⁻³ to 2 x 10⁻¹⁰ torr.

Circuitry

Six separate circuits are used in the Cenco Ionization Gage: a power supply, an electrometer type ion current amplifier, an over-pressure protective circuit, an emission current regulator, a grid outgassing circuit and a recorder output circuit. The amplifier has near 100% negative feedback to provide excellent stability in reading the ion currents from the gage tube collector. The protective circuit controls the filament circuit and, in the event of an overpressure condition, turns the filament off.

The emission regulator is a constant current device with a wide range of adjustments permitting gage tubes with different sensitivities to be used without the need for time-consuming recalibration of the amplifier. The regulator corrects for line voltage fluctuations, pressure changes, and emitter work function changes. The grid outgas circuit supplies current to the grid of the ionization gage tube to bring the grid to a bright red heat for outgassing of the gage tube walls. The recorder output is variable between 0 and 10 millivolts for full scale reading of the pressure meter.



Simplified Control Panel

Controls are grouped for easy reading and use. The pressure gage is calibrated in 100 divisions from 0 to 10. A six decade range switch can be set for readings from 10⁻³ to 10⁻¹⁰. Filament-on-and-off switches have built-in pilot lamps. The outgas circuit switch and emission gage are also mounted on the front panel.

Controller Model

The No. 94198 is provided with a SPDT, 3-ampere, contact meter relay that can be set to turn auxiliary equipment on or off at any pre-set pressure within the range of the gage. A setting control is provided on the front panel.



Specifications

OPERATING RANGE, torr	1 x 10 ⁻³ to 2 x 10 ⁻¹⁰
ZERO DRIFT, % of full scale	2
OVERPRESSURE CIRCUIT, % of full scale	125
OPERATING VOLTAGE, Volts	115
WATTAGE	
Operating	67
Outgassing	110

Gages are supplied with a 3-wire line cord and plug for connection to a power line, a 4-wire gage power cable, and a coaxial cable for ion collection.

No. 94197 without controller \$525.00
No. 94198 with controller 623.00

Ionization Gage Tubes

Hot filament tubes for use with the Nos. 94197 and 94198 Ionization Gages. All types utilize the Bayard-Alpert inverted element configuration and are suitable for measuring pressure in the range from 10⁻³ to 10⁻¹⁰ torr. The tubes are provided with three filaments that can be used separately or collectively to allow for both longer tube life and higher gage sensitivity when using higher electron currents to the grid. Tube sensitivity is 60 microamperes per micron when using 5 milliamperes grid current or 100 microamperes when using 8 1/2 ma grid current. Four types are available, three with tubulation enclosed filaments and one with filaments exposed for extremely accurate readings. Connections are provided to outgas the grid structure by passing current through the grid element.

No. 94195-1 With 3/4-inch Nonex tubulation \$35.75
No. 94195-2 With 3/4-inch Pyrex tubulation 45.00
No. 94195-3 With 3/4-inch Kovar tubulation 45.00
No. 94196 Without tubulation 64.00

CENCO OIL McLEOD GAGE

Completely portable and self-contained.

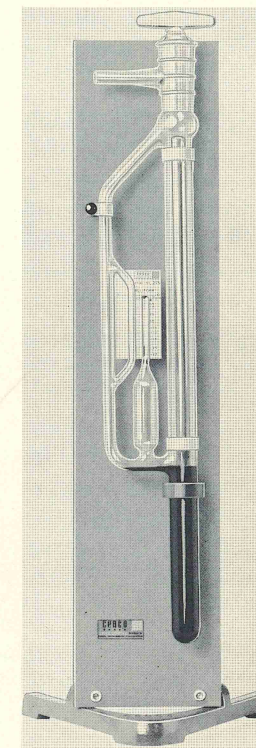
Easy to operate.

Available in three models with various ranges.

Low oil-vapor contamination.

Unaffected by sudden pressure surges.

Eliminates Mercury vapor problems.



The Cenco Oil McLeod Gage is designed for routine pressure measurements of a vacuum system being pumped by an oil-sealed rotary pump. The gage operation is based on the McLeod principle, but uses dibutyl sebacate with a color pigment as the working fluid. The unit is fabricated of Pyrex brand glass and mounted on a support panel. Connection to the system under test is made by attaching 7/16-inch ID rubber tubing to the glass stopcock of the gage. In operation, an externally mounted magnet is used to actuate an internal glass plunger. The action of the plunger displaces the volume of oil necessary to compress the sampled gas into the gage tube. The unique glass housing design has eliminated the problem of oil remaining in the capillary tube. A graduated scale in millitorr mounted behind the gage tube permits direct reading of pressure in vacuum system. The Cenco oil McLeod gage is furnished complete with support stand, glass stopcock, graduated scale and colored oil.

CENCO NO.	MEASURING RANGE (millitorr)	SENSITIVITY (millitorr)	EACH
94162-1	0-25	0.01	\$139.00
94162-2	0-150	0.1	139.00
94162-3	0-2000	1.0	139.00

Cenco Liquid Nitrogen Traps

For use in vacuum systems to condense moisture and oil vapors without materially retarding system conductance. The traps consist basically of two concentric metal tubes, top and bottom plates, a vacuum cap and inlet nipple. The bottom plate has a removable plug to permit periodic draining of the condensate. In operation, the syphon tube is connected to a vacuum pump and the collection tube to the system being evacuated. Connections can be made with either rubber tubing or with metal tubing for permanent installations. A Dewar-type flask with a suitable coolant such as liquid nitrogen or dry-ice-alcohol is required to condense the vapors in the collector tube. Cenco No. 15830-4 Dewar Flask is recommended for all sizes of traps. The traps are available in silver-soldered stainless steel. All types have an overall length of 12 inches and an effective trap length of 7½ inches.

Cenco No.	Material	Syphon Tube and Intake Nipple O.D.	Collector Tube O.D.	Each
94009-4	Stainless Stl.	1"	2"	\$59.00
94009-5	Stainless Stl.	1¼"	2¼"	67.50
94009-6	Stainless Stl.	1¾"	3"	79.00

*For ¾" water tubing, 7/8" mechanical tubing or 1" rubber tubing.
**For 1" water tubing, 1½" mechanical tubing or 1¼" rubber tubing.
***For 1½" water tubing, 1⅝" mechanical tubing or 1¾" rubber tubing.

Exhaust Filters

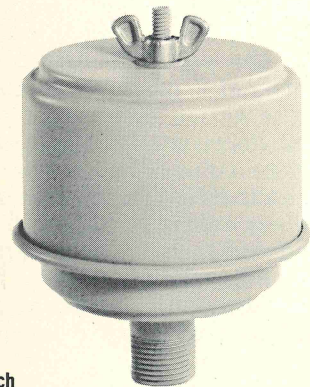
Easy to install and long lasting, these filters trap oil vapors and oil droplets which may be exhausted from mechanical pumps. The filter consists of several layers of a non-organic fiber. Oil which is separated from the air at the pump exhaust port is drained back into the pump. Available in four sizes to fit most Cenco Vacuum Pumps.

Cenco No.	Inlet Connection	Capacity CFM	For Use with	Each
93126-1	½" IPS	5	Hyvac 2* Hyvac 7 (Single or Two-Stage) Megavac	\$31.40
93126-2	¾" IPS	10	Hyvac 14 (Single or Two-Stage)	32.65
93126-3	1½" IPS	20	Hyvac 28 (Two-Stage only) Hyvac 45	36.25
93126-4	3" IPS	100	Hyvac 150, 225, 300	66.50

*Requires No. 93122 Adapter

Filter Elements

Replaceable filter elements for the No. 93126 Exhaust Filters listed above.



Cat. No.	Fits Filter No.	Each
93127-1	93126-1	\$ 8.90
93127-2	93126-2	11.65
93127-3	93126-3	15.25
93127-4	93126-4	33.50

Light Grade, Cenco-Hyvac Vacuum Pump Oil

The development of Cenco-Hyvac Oil is the result of exhaustive tests made in the Cenco laboratories. The oil incorporates two essential high vacuum characteristics: A low vapor pressure which does not materially increase at temperatures up to 50° C., and a viscosity sufficiently low for use at 15° C. that remains fairly constant up to 50° C. This oil should always be used to achieve the guaranteed performance of Cenco oil-sealed pumps.

Cenco No.	Size	Case Quantity	Each
93050-2	1 quart	12	\$0.75
93050-3	1 gallon	6	2.25
93050-4	5 gallons	6	9.50

Sylphon Packless High Vacuum Valve

With special seat for use in high vacuum systems where part of the system must be occasionally exposed to the atmosphere. A "Teflon" disk valve with stem enclosed in metallic sylphon-type bellows prevents the entrance of air through the valve stem bushings. Connections are made with standard pipe of appropriate size.

Cenco No.	Connection Size	Over-All Height	Length Between Connections	Each
94551-1	1"	7⅞"	4¼"	\$71.00
94551-2	1½"	8¼"	4⅝"	90.00

Low Pressure Solenoid Valve

For use on the intake port of Cenco Vacuum Pumps to automatically close off the evacuated system when the motor is stopped. The bodies are of aluminum finished in blue-gray hammertone, with stainless steel valve seat and armature pilot plunger. Valve diaphragm is of special synthetic rubber which withstands temperatures to 180°F. The rim of the diaphragm serves as a gasket, assuring correct alignment of assembly. Holding power consumption is 10 watts. Maximum operating range 15 lb./sq. in. Supplied with proper size close nipple to attach the valve to the pump intake after the regularly supplied nipple or coupling has been removed. No. 93062 Vacuum Sealing Compound should be used to seal the threads at the pump connection and the nipple or the coupling at the top of the valve.

Nine sizes are available. Size 1 for Hyvac 2 Pumps; Sizes 2 and 3 for Hyvac 7, Pressovac, and Megavac Pumps; Sizes 4 and 5 for Hyvac 14, Hypervac 23 and Hypervac 25 Pumps; Sizes 6 and 7 for Hyvac 28 Pumps; Sizes 10 and 11 for Hyvac 45 Pumps.

Cenco No.	IPS Thread, In.	Volts	Cycles	Each
94280-1	⅜	115	50/60	\$26.35
94280-2	½	115	50/60	28.00
94280-3	½	230	50/60	29.00
94280-4	¾	115	50/60	29.15
94280-5	¾	230	50/60	30.65
94280-6	1	115	60	42.70
94280-7	1	230	60	43.60
94280-10	1½	115	60	53.55
94280-11	1½	230	60	54.40

Extra Heavy Wall, Red Tubing, Cenco

For filter and vacuum pump connections, mercury leveling bulbs, etc. Made to our special formula for high-vacuum work. Sold in minimum lengths of 5 feet in sizes 1 to 3 and 1 foot in sizes 6 to 11.

No. 18204	-1	-2	-3	-6	-8	-11
ID, inch	⅛	⅜	¼	⅝	¾	1⅜
Wall thickness, inch	⅜	⅝	⅝	⅝	¾	1⅜
Price per foot, \$	0.31	0.50	0.54	1.05	1.50	1.75

Cenco High-Speed Diffusion Pumps

Operating Specifications	4-Inch Pump	6-Inch Pump	10-Inch Pump
MAXIMUM PUMPING SPEED, liters per second	1000	2000	4500
OPERATING PRESSURE, torr (mm of Hg)	From 2 x 10 ⁻³ to less than 1 x 10 ⁻⁹		
LIMITING FOREPRESSURE, torr			
At full load	0.65	0.50	0.45
At no load	0.80	0.70	0.60
PUMP FLUID			
Recommended Cenco No.	93264	93264	93264
Quantity, cc	395	630	1815
COOLING WATER REQUIREMENTS, gallons per min. at 20°C	0.25	0.40	0.75
HEATER			
Voltage	115	115	230
Wattage	1200	1800	3600
FOREPUMP REQUIREMENTS, Cubic ft. per minute	5	10	25
RECOMMENDED FOREPUMP	HYVAC 14	HYVAC 28	HYVAC 150

Pumps are available with either stainless steel bodies and flanges for maximum service or with more moderately priced carbon steel bodies and flanges. Both stainless steel and carbon steel models are furnished complete as described with stainless steel jets but without pumping fluid, powerstat or forepump.



Cenco No.	Type and Size	Each
93405	Stainless Steel 4-Inch Pump	\$ 395.00
93406	Carbon Steel 4-Inch Pump	360.00
93410	Stainless Steel 6-Inch Pump	535.00
93411	Carbon Steel 6-Inch Pump	465.00
93415	Stainless Steel 10-Inch Pump	1400.00
93416	Carbon Steel 10-Inch Pump	1250.00

10 price list

10.1 MOUNTED HYVAC VACUUM PUMPS

Cenco No.	Price
HYVAC 2	
91305-1	\$148.50
91305-7	166.50
91305-10	189.00
91305-18	175.50
91305-23	125.75
91308-1	162.85
91308-7	172.15
91308-10	195.45
91308-18	181.50
91308-23	135.85

Cenco No.	Price
HYVAC 6	
91492-1	\$249.00
91492-7	259.50
91492-10	299.50
91492-18	253.00
91492-23	210.00

Cenco No.	Price
HYVAC 7	
91506-1	\$284.25
91506-7	292.50
91506-10	324.50
91506-18	298.50
91506-23	240.00

Cenco No.	Price
HYVAC 14	
91482-1	\$239.00
91482-7	249.50
91482-10	289.25
91482-18	243.00
91482-23	199.50

Cenco No.	Price
HYVAC 14	
91705-1	\$388.00
91705-7	402.00
91705-10	425.00
91705-18	396.00
91705-23	340.00

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- Vacuum*, the International Journal and Abstracting Service for Vacuum Science and Technology, published monthly by Pergamon Press, London.
- Vakuum-Technik*, Organ of the Deutsche Arbeitsgemeinschaft Vakuum, published 8 times per annum by R. A. Lang, Esch/Taunus, Germany.

10.2 UNMOUNTED HYVAC VACUUM PUMPS WITHOUT MOTOR

Cenco No.	Model	Price
91300	Hyvac 2	\$132.50
91306	Hyvac 2	139.50
91480	Hyvac 4	187.50
91490	Hyvac 6	197.50
91502	Hyvac 7	227.50
91700	Hyvac 14	310.50
91900	Hyvac 28	475.00
91950	Hyvac 45	525.00

Central Scientific Co.
1700 IRVING PK. RD.
CHICAGO, ILLINOIS 60613



mechanical vacuum pumps

A COMPLETE LINE OF HIGH VACUUM PUMPS, GAGES, SYSTEMS, & COMPONENTS

MAKERS OF THE WORLD RENOWNED HYVAC® PUMPS

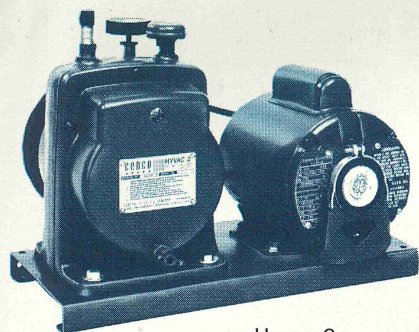
CENCO HYVAC PUMP



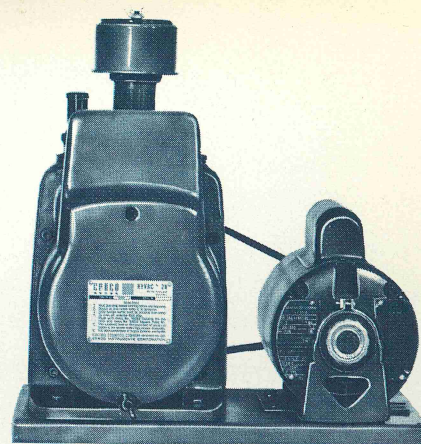
A two-stage, oil sealed mechanical pump of the internal moving vane design for pumping down to 0.05 microns of vacuum with high speed. Its reasonable cost and size make this dependable pump ideal for research and educational laboratory applications. It has also found wide acceptance in the chemical process industry where a continuous high vacuum is required.

		GUARANTEED VACUUM (millitorr of mercury)	CAPACITY at atmosphere at 1 millitorr (liters per min.) (liters per min.)		BOOKLET
SINGLE STAGE PUMPS					329
	Hyvac 7	10.0	79	—	
	Hyvac 14	5.0	140	—	
	Hyvac 28	5.0	280	—	
	Hyvac 45	5.0	450	—	
DOUBLE STAGE PUMPS	Pressovac	15.0	35	—	325
	Blower Pump	3 IN. Hg.	35	—	326
	Hyvac	0.3	10	5	320
	Hyvac 2	0.1	25	13	321
	Hyvac 4	0.05	48	25	
	Hyvac 6	0.1	65	30	
	Hyvac 7	0.1	79	35	
	Hyvac 14	0.1	140	75	
	Hyvac 28	0.05	280	150	319
	Hyvac 45	0.05	450	280	
	Hyvac 150	0.05	1500	1275	
	Hyvac 225	0.05	2250	1800	
	Hyvac 300	0.05	3000	2250	323
	Megavac	0.1	57	22	
	Hypervac 23	5.0	240	—	324
	Hypervac 25	0.1	264	120	
	Hypervac 100	0.1	960	660	

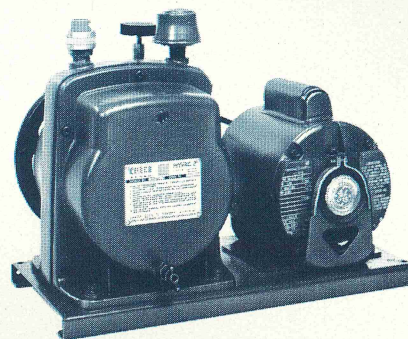




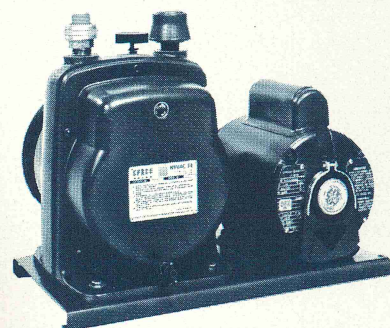
Hyvac 2



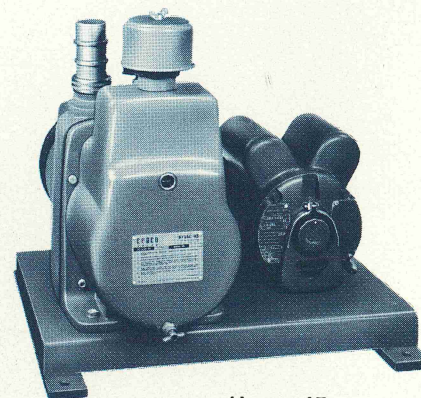
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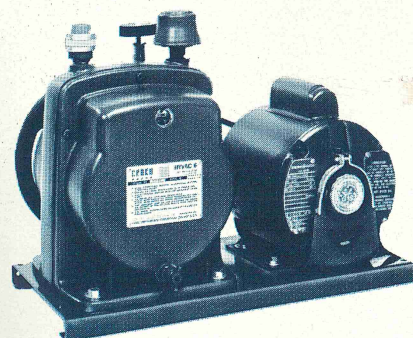
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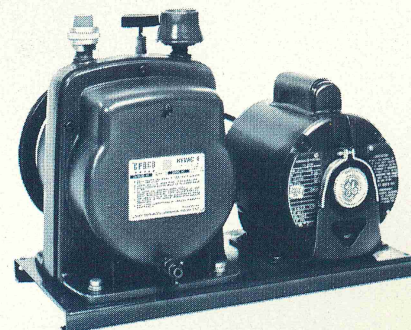
Hyvac 14



Hyvac 45



Hyvac 6



Hyvac 4

Cenco Double Stage Vacuum Pumps: Hyvac 2, 4, 6, 7, 14, 28, and 45

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1 introduction

1.1 General: The Cenco Hyvac 2, 4, 6, 7, 14, 28, and 45 Pumps are two-stage, high-capacity mechanical vacuum pumps based on Gaede's internal-vane principle. Combining quiet, vibrationless operation, and high pumping speed with low ultimate pressure, these Cenco Hyvac Pumps are best suited for heavy-duty vacuum work, such as evacuating space chambers, pumping down large vacuum furnaces, and backing ultra-vacuum diffusion pumps in environmental testing and space condition simulation. These pumps may also be used as roughing pumps in general-purpose high vacuum applications and as forepumps in conjunction with diffusion pumps, such as Cenco Nos. 93415 and 93416. Specifically, the Cenco Hyvac Pumps can be used in the following high-vacuum commercial applications:

- **Vacuum Metallurgy** — Thermal Reduction, Distillation of Metals, Vacuum Sintering, Heat Treatment, Vacuum Melting
- **Vacuum Dehydration** — Blood Plasma, Biologicals, Foods
- **Vacuum Evaporation** — Low-Reflection Coatings on optical surfaces and reflecting surfaces, Decorative Coatings, Electrically Conductive Coatings
- **Vacuum Sputtering** — Coating of Non-Conductors
- **Vacuum Distillation** — Distillation Point Reduction, Molecular Distillation
- **Vacuum Impregnation** — Condensers, Coils, Transformers, Cables, and other electrical insulating materials
- **Miscellaneous** — Manufacture of Refrigerators, Bellows-type Barometers, Vapor-operated Thermometers; Television Receivers, Vacuum Bottles, etc.; Evacuation of High-voltage X-ray Tubes, Large Magnetrons, Cathode-Ray Tubes.

1.2 Plus Features of the Cenco Hyvac Pumps

- High-conductance, internal connections be-

tween intake and exhaust stages for optimum pumping performance.

- Arrangement of lubrication ducts for positive sealing and effective lubrication of all rotating components of the pump.
- Internal relief valve arrangement for starting the pump against an evacuated vacuum system.
- Standard pipe thread inlet connections.

2 principle of operation

2.1 Single-Stage Pump: Since the Hyvac 2, 4, 6, 7, 14, 28 and 45 Pumps incorporate two, distinct, single stages mounted back to back, to understand how a two-stage pump works, it is only necessary to understand the operating principle of a single-stage pump.

A typical, internal-vane, vacuum pump consists of a motor-driven cylindrical rotor eccentrically mounted within a larger housing, or stator. Two spring-loaded vanes are mounted in the rotor, parallel to its axis, in diametrically opposed slots. The vanes bear against the wall of the stator under spring pressure and centrifugal action. The eccentric mounting of the rotor provides a permanent point of contact between stator and rotor and divides the stator in two sections, or stages: intake and exhaust. A thin film of oil at the point of contact maintains effective vacuum sealing, thus preventing the passage of gas between stages. Two openings in the stator serve as gas intake and exhaust ports. The intake port is connected to the system to be evacuated.

Figure 1 illustrates the internal vane principle, on which Gaede built his "Kapselpumpe" in 1910. As the pump is driven by a motor, the rotor turns, and the spring-loaded vanes slide in and out of their slots, maintaining positive contact with the wall of the stator throughout every revolution. As a result, gas in the space between the two vanes is pushed forward, compressed to atmospheric pressure, and expelled through the exhaust while additional gas is sucked in through the intake.

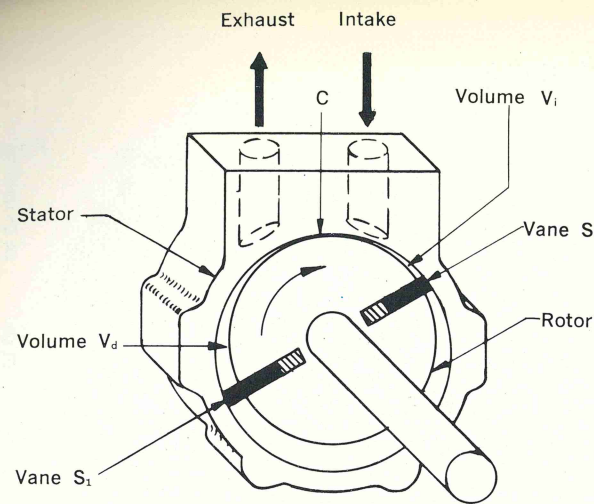


Fig. 1—Operating principle of an internal-vane vacuum pump

As the rotor turns, the volume behind Vane *S* increases from the instant vane *S* slides past the sealing area, or contact point *C*. This increasing volume V_i allows more gas from the system being evacuated to enter the intake stage. At the same time, the volume V_d ahead of vane *S*₁ decreases, thereby forcing gas to be compressed and expelled from the exhaust stage. The compressed gas is kept from entering the intake stage by the oil seal at the contact point *C*. A single stage pump of this type produces a vacuum of about 5 millitorr.

2.2 Two-Stage Pump: A typical two-stage vacuum pump incorporates a high-vacuum stage and a roughing stage, connected in series. The stages are mounted side by side and are separated by a common wall—ground plane parallel—through which a hole has been drilled. The hole serves as both the exhaust port of the high-vacuum stage and the intake port of the roughing stage. While volume V_d in the former is decreasing, air is being expelled in volume V_i of the roughing stage. The air in the volume V_d of the high-vacuum stage is not compressed appreciably; as a result, leakage into the high-vacuum stage is minimized. A two-stage pump of this type produces a vacuum of 1 millitorr or better.

3 specifications

3.1 Pump Data: The speed-pressure characteristics of the Cenco Hyvac Pumps are illustrated in Fig. 2. The following table lists additional pump data and specifications:

Pump Model	Hvac 2	Hvac 4	Hvac 6	Hvac 7	Hvac 14	Hvac 28	Hvac 45
Pump speed (rpm)	580	325	440	525	525	525	550
Capacity at atmospheric pressure (liter/min.)	25	46	65	79	140	280	450
Capacity at 1 millitorr (liter/min.)	13	25	30	35	75	150	280
Guaranteed vacuum (millitorr)	0.1	0.05	0.1	0.1	0.1	0.05	0.05
Merit Factor, (%) ¹	52	54	46	44	54	54	62
Gas Ballast	optional	yes	yes	yes	yes	yes	yes
Motor Horsepower, hp	0.25	0.33	0.33	0.33	0.50	1.00	1.00

¹The merit factor is the ratio of the pumping speed at one millitorr to the pumping speed at atmospheric pressure.

Cenco Hyvac Pumps are available in three stages of assembly: mounted on a base and equipped with motor, mounted without motor, and unmounted. For customer convenience, the Cenco Number of each pump model is followed by a dash number

(-1, -7, -10, -18, and -23) which indicates the assembly stage of the pump and/or the type of motor supplied with the pump. Thus, pumps mounted with motors are identified in the following manner:

Dash No.	Type of Motor
-1	115/230-volt, 60-cycle
-7	115/230-volt, 50-cycle
-10	115/230-volt, 60-cycle (explosion-proof)
-18	220/440-volt, 50/60-cycle

Mounted pumps without motor are identified by a -23.

3.2 Mounted Pumps: Mounted Hyvac Pumps, with or without motor, are shipped mounted onto a heavy metal base and are supplied with a grooved pulley, a molded rubber V belt, enough oil for one filling (see Section 5.7), and an instruction booklet. All the mounted versions of the Hyvac series and their corresponding Cenco Nos. are listed in Table I.

3.3 Unmounted Pumps: Unmounted Hyvac Pumps (see Table below) are supplied with a grooved pulley, enough oil for one filling, and an instruction booklet. Four holes are provided on each unmounted pump for fastening it onto a suitable base. A motor with grooved pulley and rubber V belt is needed to drive the pump at operational speed. The motor should have the same hp rating as that supplied with the Hyvac mounted-series pumps. For specifications, see Section 3.1 and Table II. For specific needs, special motors are available from Cenco on request. Unmounted Hyvac pumps are listed in the table below.

Cenco No.	Model	Gas Ballast
91300	Hvac 2	No
91306	Hvac 2	Yes
91480	Hvac 4	Yes
91490	Hvac 6	Yes
91502	Hvac 7	Yes
91700	Hvac 14	Yes
91900	Hvac 28	Yes
91950	Hvac 45	Yes

4 description

The Cenco Hyvac 2, 4, 6, 7, 14, 28, and 45 Pumps are two-stage, series-connected, internal-vane, mechanical vacuum pumps. In operation, rotary motion is imparted to the pump mechanism by a belt drive connected to a powerful, electric motor. An all-metal belt guard completely encloses the belt drive for personnel safety.

The two stages, intake and exhaust, consist of cylindrical chambers in which rotors are mounted eccentrically to provide a high-vacuum seal between the rotors and the chambers. The intake and exhaust ports of each stage are located on both sides of the sealing area. Two spring-loaded, sliding vanes are mounted in the slots of each rotor.

Lubricating oil for the exhaust stage enters through the bearing and oil holes in the exhaust endplate. Oil flow to the intake stage is controlled by the centerplate bearing and degassed by the exhaust stage before it is allowed to reach the intake stage. The intake nipple and exhaust dome are connected to the centerplate of the pump. The centerplate contains a large intake volume so that oil will not "back up" into the system if the pump is stopped and left connected to the system under vacuum for a long

Table I
HYVAC MOUNTED-PUMP SERIES: MODEL AND CENCO NUMBERS

Without Gas Ballast	With Gas Ballast							MOTOR RATING	
HYVAC 2 Cenco No.	HYVAC 2 Cenco No.	HYVAC 4 Cenco No.	HYVAC 6 Cenco No.	HYVAC 7 Cenco No.	HYVAC 14 Cenco No.	HYVAC 28 Cenco No.	HYVAC 45 Cenco No.	Voltage, Volts	Type Cycles
91305-1	91308-1	91482-1	91492-1	91506-1	91705-1	91905-1	91955-1	115/230	60
91305-7	91308-7	91482-7	91492-7	91506-7	91705-7	91905-7	91955-7	115/230	50
91305-10*	91308-10*	91482-10*	91492-10*	91506-10*	91705-10*	91905-10*	91955-10*	115/230 115	60 60
91305-18	91308-18	91482-18	91492-18	91506-18	91705-18	91905-18	91955-18	220/440	50/60
91305-23	91308-23	91482-23	91492-23	91506-23	91705-23	91905-23	91955-23	no motor supplied	

* Explosion-Proof

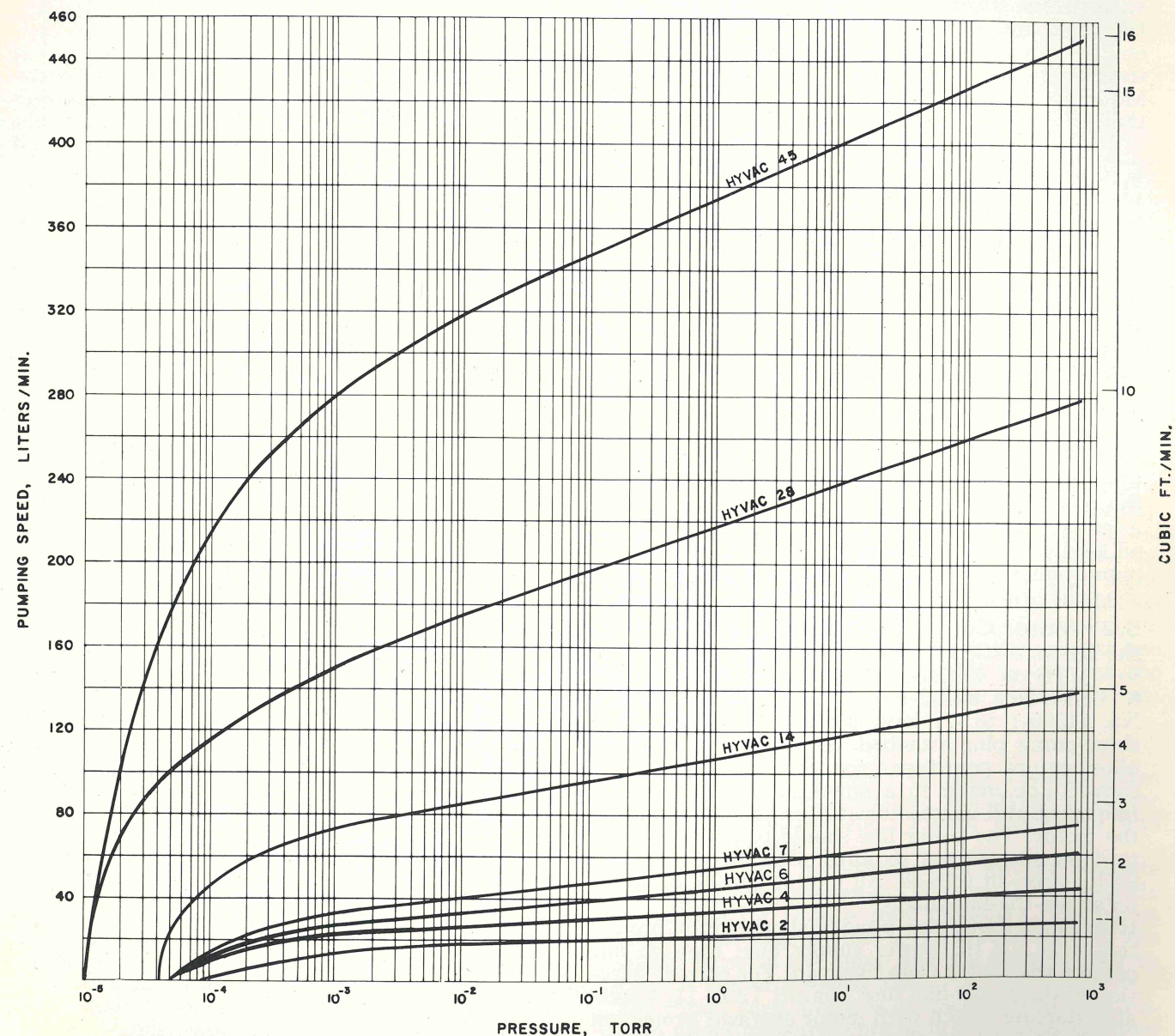


Fig. 2—Pumping speed and pressure characteristics of the Cenco Hyvac 2, 4, 6, 7, 14, 28, and 45 Pumps

period of time. The intake and exhaust stages are supported by the centerplate. Around the stages, and bolted to the centerplate, are the two housings. The housings contain the oil bath, in which both stages are submerged.

The oil bath insures a vacuum-tight seal of the stages; cools the pump interior; and lubricates the moving parts through the oiling holes. The lubricating oil is degassed by the exhaust stage before it is allowed to reach the intake stage. Eventually, the oil becomes contaminated with volatiles and water droplets, and it must be replaced.

To prevent contamination of the pump oil when condensable vapors are pumped, a gas ballast feature has been incorporated in the Hyvac pumps. The gas ballast valve, located at the rear of the housing, allows regulation of the air flow (gas ballast) during the compression cycle of the stage. This ballast flow reduces the compression ratio of the vapor in the stage, thus preventing condensation of the vapor and emulsification with the oil. Mounted on the pump is an exhaust-filter dome that effectively traps oil in the exhaust.

Mounted on the two housings are the drain cock, the oil level sight gage, and the oil shaft seal.

5 installation

5.1 Pump Mounting: Each mounted pump is shipped ready for immediate installation. An unmounted pump, however, first should be mounted on a flat, rigid, steel or cast-iron base, such as that supplied with the mounted unit. The major dimensions of the pump, pump base and motor are given in Figs. 3 and 4. Provisions should be made for bolting the base to the floor or, if the pump is to be used in a movable unit, to the frame. When electronic equipment is attached to the same frame, shock mounts should be installed so that vibrations from the motor or pump will not be transmitted through the frame.

A pump should be mounted perfectly level so the oil level can be read accurately. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump.

5.2 Motor Connections: Motors supplied with the Hyvac 2 (Cenco Nos. 91305-1 to -7 and 91308-1 to -7), Hyvac 4 (Cenco Nos. 91482-1 to -7), Hyvac 6 (Cenco Nos. 91492-1 to -7), and Hyvac 7 (Cenco No. 91506-1 to -7) have a connecting cord and a three-prong plug attached. All other pump assemblies require permanent connections. In all cases, connect the motor to a power line of the voltage, frequency and phase indicated on the nameplate of the motor. The power line should be heavy enough to carry the current required without causing any undue drop in voltage. All motors can be operated on across-the-line start.

Remember that fuses provide short-circuit protection only for the power supply line; they do not protect the motor from overload. For correct selection of the power-line fuse, consult Table II. A suitable starting switch with motor overload protection should be used for all permanent installations.

5.3 Vacuum Connections: The Hyvac 2, 28, and 45 pumps are provided with one-piece intake nipples which are intended primarily for use with rubber tubing. The Hyvac 4, 6, 7 and 14 are provided with a vacuum coupling as illustrated in Fig. 5 and Fig. 7.

Table II
MOTOR ELECTRICAL DATA

Pump Model	Cenco Pump No.	Current at Full Load (Amperes)			Max. Fuse Rating (Amperes)		
		at 115V	at 230V	at 440V	at 115V	at 230V	at 440V
Hylvac 2	91305-1 91308-1	4.4	2.2	..	..	..	..
	91305-7 91308-7	4.8	2.4	..	..	..	..
	91305-10 91308-10	4.4	2.2	..	15	15	15
	91305-18 91308-18	..	1.1	0.6	..	..	..
Hylvac 4	91482-1	5.6	2.8	..	20	..	..
	91482-7	6.2	3.1	..	25	..	..
	91482-10	5.6	2.8	..	20	15	15
	91482-18	..	1.6	0.8	..	..	..
Hylvac 6	91492-1	5.6	2.8	..	20	..	..
	91492-7	6.2	3.1	..	25	..	..
	91492-10	5.6	2.8	..	20	15	15
	91492-18	..	1.6	0.8	..	..	..
Hylvac 7	91506-1	5.6	2.8	..	20	..	..
	91506-7	6.2	3.1	..	25	..	..
	91506-10	5.6	2.8	..	20	15	15
	91506-18	..	1.6	0.8	..	..	..
Hylvac 14	91705-1	7.8	3.9	..	..	..	..
	91705-7	7.4	3.7	..	25	15	15
	91705-10	7.8	3.9	..	..	..	..
	91705-18	..	1.9	0.9	..	..	..
Hylvac 28	91905-1	13	6.5	..	..	..	..
	91905-7	12	6.0	..	30	15	15
	91905-10	13	6.5	..	..	..	..
	91905-18	..	3.6	1.8	..	..	..
Hylvac 45	91955-1	13	6.5	..	..	..	..
	91955-7	12	6.0	..	30	15	15
	91955-10	13	6.5	..	..	..	..
	91955-18	..	3.6	1.8	..	..	..

It is recommended that the following procedure be observed before making any vacuum connections:

- (1) Remove the plastic protector from the hose nipple (or vacuum coupling).
- (2) Remove the plug from the exhaust port, and install the exhaust dome.
- (3) Remove the drain plug and install the drain cock.
- (4) When making glass connections between the pump intake nipple and the vacuum system, use a short rubber hose as a coupling between nipple and glass tube, and take extreme care to eliminate any source of leakage.
- (5) Make sure that both members of each connection are coated with vacuum stopcock grease and that all connections to metal or glass tubing fit snugly. It is best to solder or braze all metal connections.
- (6) If threaded pipe joints are used, the threads should be as perfect as possible. When making threaded connections, screw the members together a few turns, and then apply Glyptal to the exposed threads before screwing them tightly together. Allow the Glyptal to dry for several hours before starting the pump.
- (7) If flanged connections are used, install flat or "O" ring gaskets, made of rubber or Neoprene, between the flanges to prevent leakage. Place a thin coat of oil on the "O" ring before installation. Cenco No. 90020-25 Vacuum Seals may be used for intake flange connections.
- (8) Rubber tubing connections should be made with an extra-heavy-wall gum tubing, such as No. 18204, which has been compounded specially for vacuum work.
- (9) For maximum gas flow and minimum pressure drop, make all vacuum connections as short as possible, and use tubing of as large a diameter as possible.

The conductance of various sizes of tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008, or may be determined from Fig. 6, in which the quantity $(L + \frac{4}{3}D)$ is plotted against Z , the conductance in cubic centimeters per second. The symbols L and D represent the length and inside diameter of the tubes in centimeters. The average pumping speed of the system, then, may be found by solving the following relationship:

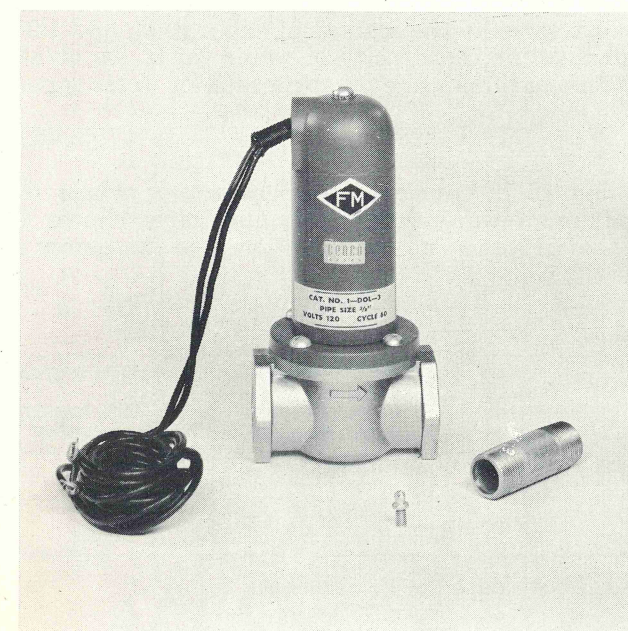
$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pumping speed, taken from Fig. 2, and Z is the conductance of all the tubing or the connecting line between the pump and the system. The time required to evacuate a vessel of volume V is given by the formula:

$$T = \frac{2.3V}{S} \cdot K$$

where T is the time in seconds, V the volume of the vacuum system expressed in liters, and S the average pumping speed expressed in liters per second, for operation from atmospheric to final pressure. The factor K has values of 4, 5, and 6. The value 4 is used for a final pressure of 100 millitorr, 5 for 10 millitorr, and 6 for 1 millitorr.

5.4 Valve Connections: Generally, metal vacuum valves and glass stopcocks are employed in the connecting line between the pump and the system for connecting the vacuum gage and for releasing the vacuum system after pumping has been terminated. When metal tubing is used, a high-vacuum valve, such as No. 94551 or 94280, is recommended.

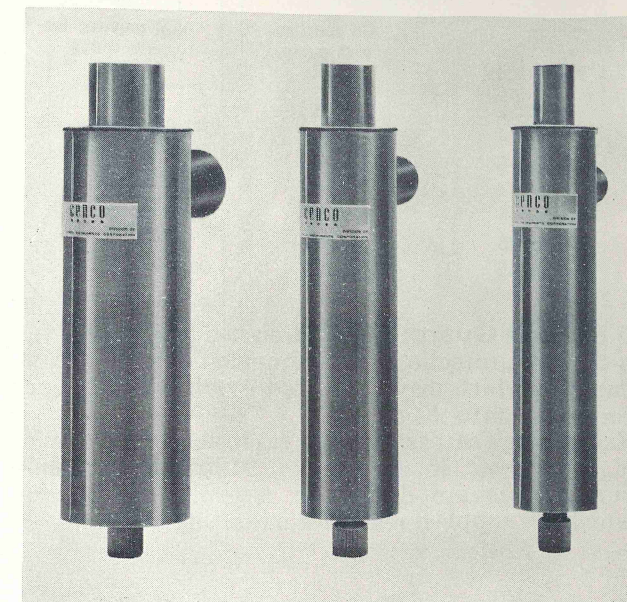


Low-Pressure Solenoid Valve, Cenco No. 94280

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of leak-testing the pump and the system by the pressure-rise method without disconnecting the pump from the line.

5.5 Vacuum-System Traps: Extreme care must be taken to prevent solid particles from reaching the intake of the pump, otherwise they will score the working parts of the pump and reduce its efficiency. If corrosive vapors are present in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor (from the pump) from entering the system.

A Cenco No. 94009 Liquid Nitrogen Trap is recommended for this purpose. For detailed specifications on the traps, refer to Section 8, Accessories.



Liquid Nitrogen Traps, Cenco No. 94009

If large amounts of water vapor are pumped and a large ballast flow is used, some oil mist will be discharged with the ballast air and vapor. It is a good hygienic practice to pipe the exhaust outside the work area. For this purpose, remove the filter dome and connect a 3-inch IPS pipe directly to the exhaust outlet. For best performance, a simple condensing trap should be provided in the exhaust line as close to the pump as possible to prevent the condensate, which will form in the pipe, from running back into the pump.

5.6 Gages: The types of high vacuum gages commonly used in a system employing a Hyvac pump are the McLeod, Pirani, discharge, and thermocouple gages.

A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 mm Hg to 1.6 mm Hg (0.5 to 1600 millitorr). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint.

The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 millitorr and from 1 to 50 millitorr.

The Thermocouple gage permits pressure measurements in the range from 1 to 1000 millitorr.

The Discharge gage operates within the range of 0.001 to 20 millitorr.

All vacuum gages are illustrated and described in Section 8, Accessories.

5.7 Oil Requirements: Each Hyvac Pump is shipped with the oil drained from the reservoir. Oil is supplied for the first filling and for periodic oil changes. To fill the pump with oil, remove the exhaust dome and pour oil through the opening up to the oil level sight gage. Turn the pump pulley several revolutions by hand while filling the pump with oil. The oil level window indicates the correct oil level. If insufficient oil is used, a good seal around the vanes may not be maintained. *If too much oil is used, oil may back up through the pump trap and into the vacuum system.*

Pump Model	Oil supplied with pump, Pints	Oil required for one filling, Pints
Hyvac 2	3	2
Hyvac 4	4	3
Hyvac 6	4	3
Hyvac 7	4	3
Hyvac 14	8	5
Hyvac 28	8	7
Hyvac 45	10	9

5.8 Belt Guard: Cenco-designed belt guards furnish ideal protection for personnel and pump against damages which may be caused by objects falling on the belt or into the pulley. Except for the base on the explosion-proof version of the Hyvac 45, Cenco No. 91955-10, all Cenco pump bases are drilled to receive these guards, which are supplied ready for mounting.

6 operation

6.1 Starting up the Pump: When a large rotary vacuum pump is turned off without being let up to atmosphere on its intake side, oil, driven by atmospheric pressure, begins to fill the volume between stator and rotor. Because the pump and its valves are designed to handle compressible gas, not incompressible oil, sometimes the electric motor cannot turn the rotor over against the resistance of oil-filled passages. To prevent this difficulty, never leave a pump turned off for more than a few minutes while it is still connected to a vacuum. *If the pump has been properly installed, it will begin to pump immediately each time the motor is turned on.*

NOTE: Oil shooting from the exhaust dome of an operating pump indicates that the pump contains too much oil. If this happens, stop the pump and drain oil slowly until the oil level is at the proper height. It is good vacuum practice to take an occasional check of the oil level while the pump is running.

6.2 Gas Ballast: The gas ballast pump is ideally suited for pumping all vapors which do not chemically attack or dissolve in the pump oil; water is a typical example. Even after contamination of the oil has occurred, the gas ballast pump is able to purify the oil if the system is temporarily shut off from the pump and the pump is kept running for a suitable length of time. The contaminated oil will continually circulate from the oil supply channel into the high vacuum side, where the contaminant will evolve as vapor. This vapor then will be dis-

charged with the ballast air as described before, until eventually all the contaminant has been expelled. For this reason, the oil of pumps employing the gas ballast does not have to be changed as often as the oil of pumps which do not have the gas ballast. Although it is impossible to calibrate the gas ballast control for all pumps at all operating pressures, it is useful to know the effectiveness of different gas ballast flow rates on the pumping of vapors. The following formula will enable the user to calculate the maximum pumping rate of insoluble vapors without their contaminating the pump oil:

$$W = DV \cdot \frac{P_a}{P_e - P_s} \cdot \frac{T_p}{T_a} \text{ (g/min)}$$

where:

T_p = pump temperature ($^{\circ}\text{K}$) (taken as pump oil temperature)

 T_a = ambient temperature ($^{\circ}\text{K}$) P_a = barometric pressure (torr)

P_s = saturation pressure of pumped vapor at pump temperature T_p (torr)

P_e = pressure under pump exhaust valve at instant of exhausting (torr)

V = rate of dry gas ballast flow at atmospheric pressure P_a (lit/min)

D = density of pumped vapor at temperature T_p
and pressure P_s (g/lit)

W = maximum safe mass rate for pumping vapors (g/min)

Solving for the special and frequently encountered situation of pumping water vapor, and treating this vapor as a perfect gas so that at exit

$$D_{\text{water vapor}} = \frac{18}{22.4} \cdot \frac{P_s}{760} \cdot \frac{273}{T_p}$$

$$= 0.289 \frac{P_s}{T_p} \text{ (g/l)}$$

and assuming a pressure of 850 torr below the exhaust valve at the instant of exhaustion, and then substituting the density of water vapor, we obtain as the maximum safe pumping rate for water vapor:

$$W_{\text{water vapor}} = 0.289 \left(\frac{V}{T_a} \right) \left(\frac{P_a P_s}{850 - P_s} \right) (\text{g/min})$$

Using 10 lit/min gas ballast flow, we obtain the maximum water-vapor pumping rates shown in Table III when no condensation is in the pump:

Table III
WATER-VAPOR PUMPING RATES

Pump Temperature in °C	Maximum Water-Vapor Pumping Rate in g/min	
	With zero humidity in gas ballast air	With 100% humidity in gas ballast air
50	0.91	0.72
60	1.60	1.39
70	2.84	2.59
80	5.38	5.08

For above data

$$\begin{aligned} P_a &= 760 \text{ torr} \\ T_a &= 20^\circ \text{C} = 293^\circ \text{K} \end{aligned}$$

The gas ballast flow can be adjusted by turning the gas ballast valve, located near the exhaust filter dome.

If the ultimate vacuum of the pump is not required, it is possible to obtain almost noiseless operation by "cracking" open the gas ballast valve. The ultimate pressure which can be obtained in this instance is approximately 30 millitorr.

[illegible]

	16	16	16	16
*THESE DIMENSIONS APPLY ALSO TO HYVAC 4 AND HYVAC 6.				

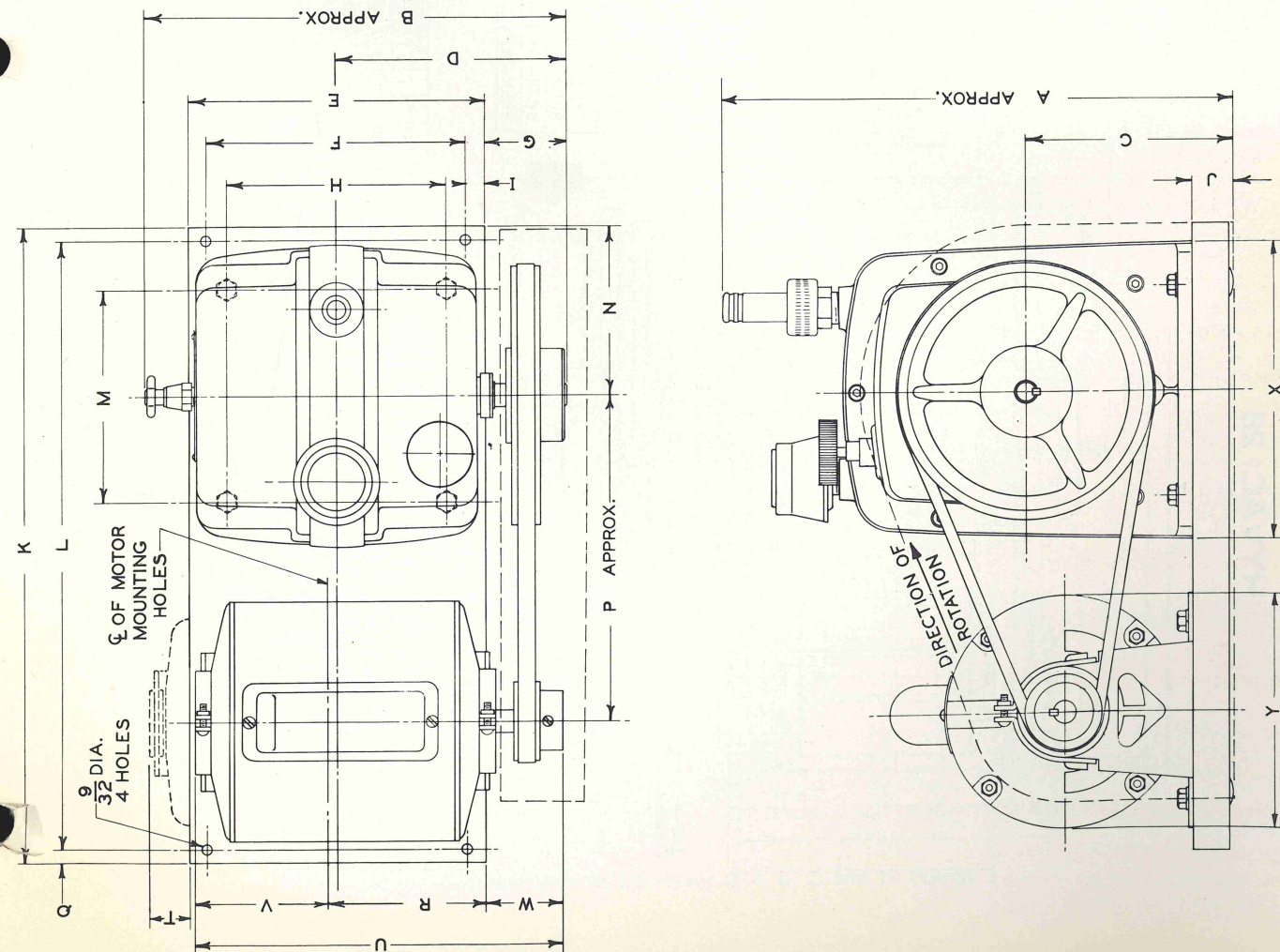
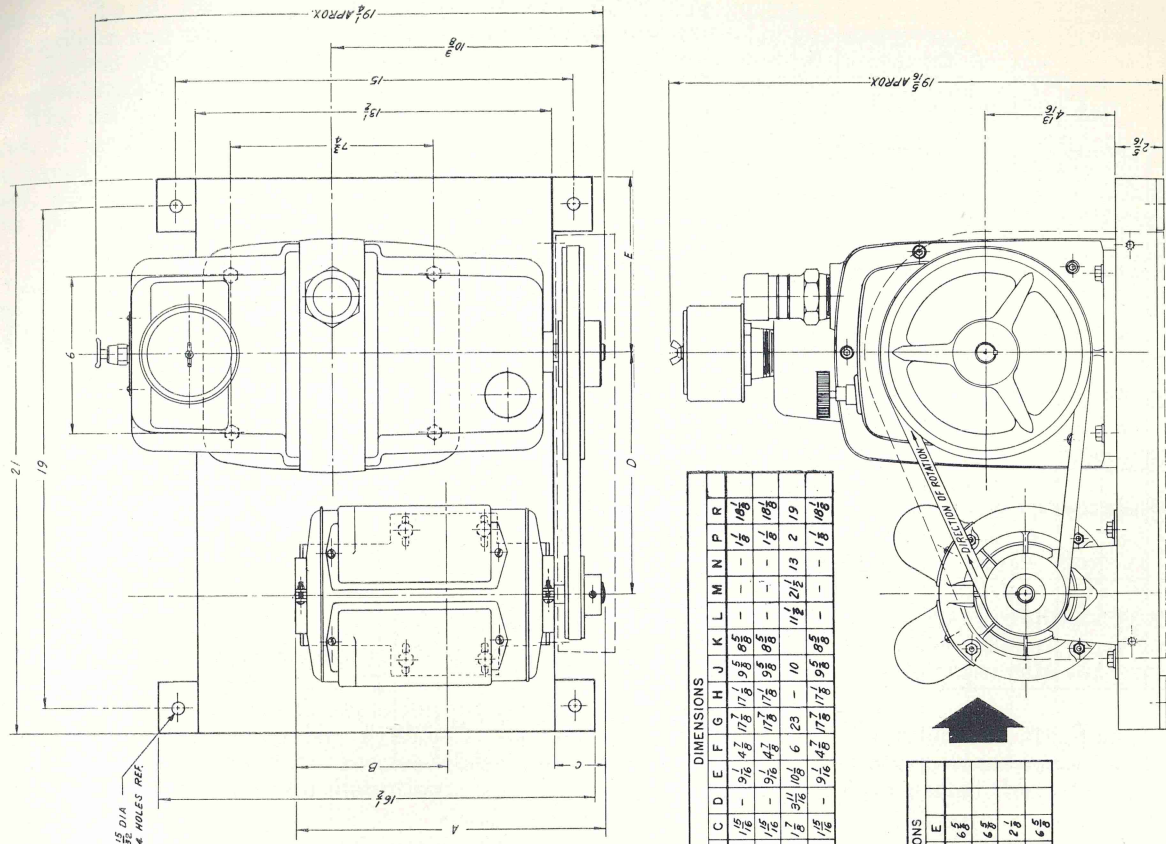


Fig. 3—Major dimensions of the Hyvac 2, 4, 6, 7, and 14 Pumps

HYVAC 45



CATALOG NO.	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
91905-1	1 1/8	5 1/2	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8
91905-7	1 1/8	5 1/2	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8
91905-10	1 1/8	5 1/2	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8
91905-18	1 1/8	5 1/2	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8

CATALOG NO.	A	B	C	D	E
91955-1	1 1/8	5 1/2	1 1/8	1 1/8	1 1/8
91955-7	1 1/8	5 1/2	1 1/8	1 1/8	1 1/8
91955-10	1 1/8	5 1/2	1 1/8	1 1/8	1 1/8
91955-18	1 1/8	5 1/2	1 1/8	1 1/8	1 1/8

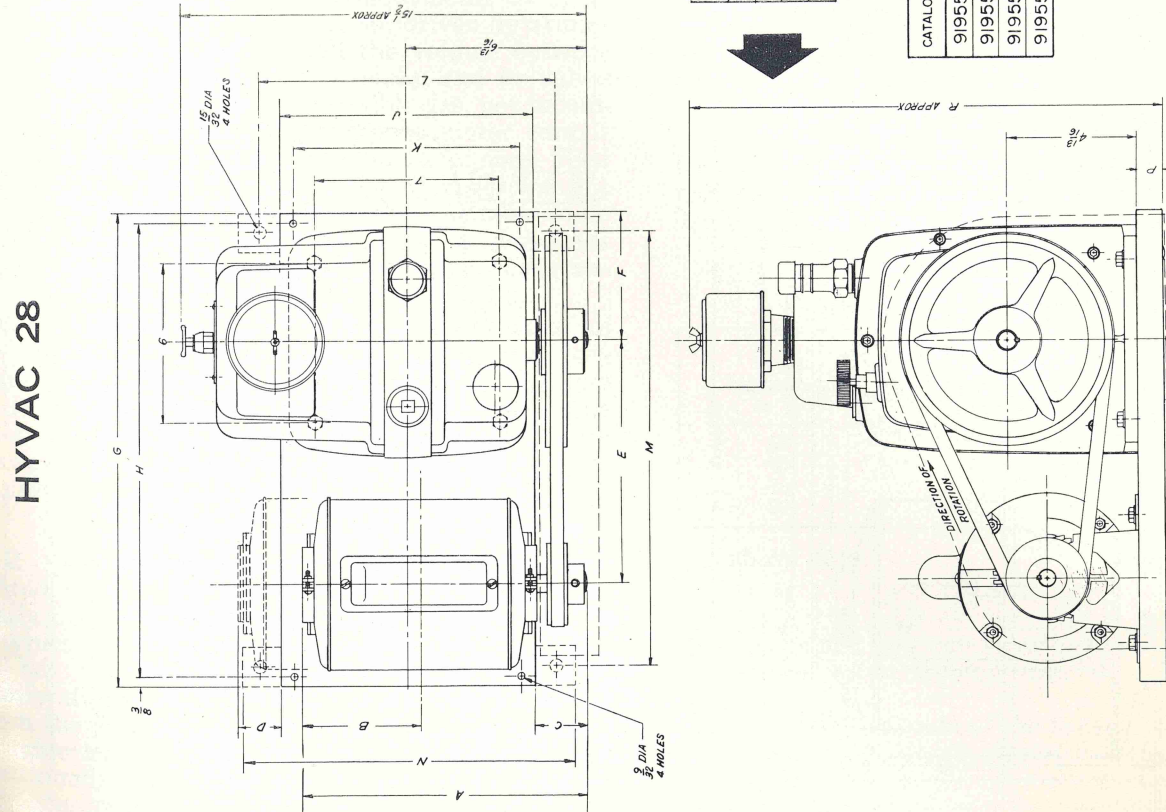


Fig. 4—Major dimensions of the Hyvac 28 (left) and Hyvac 45 Pumps

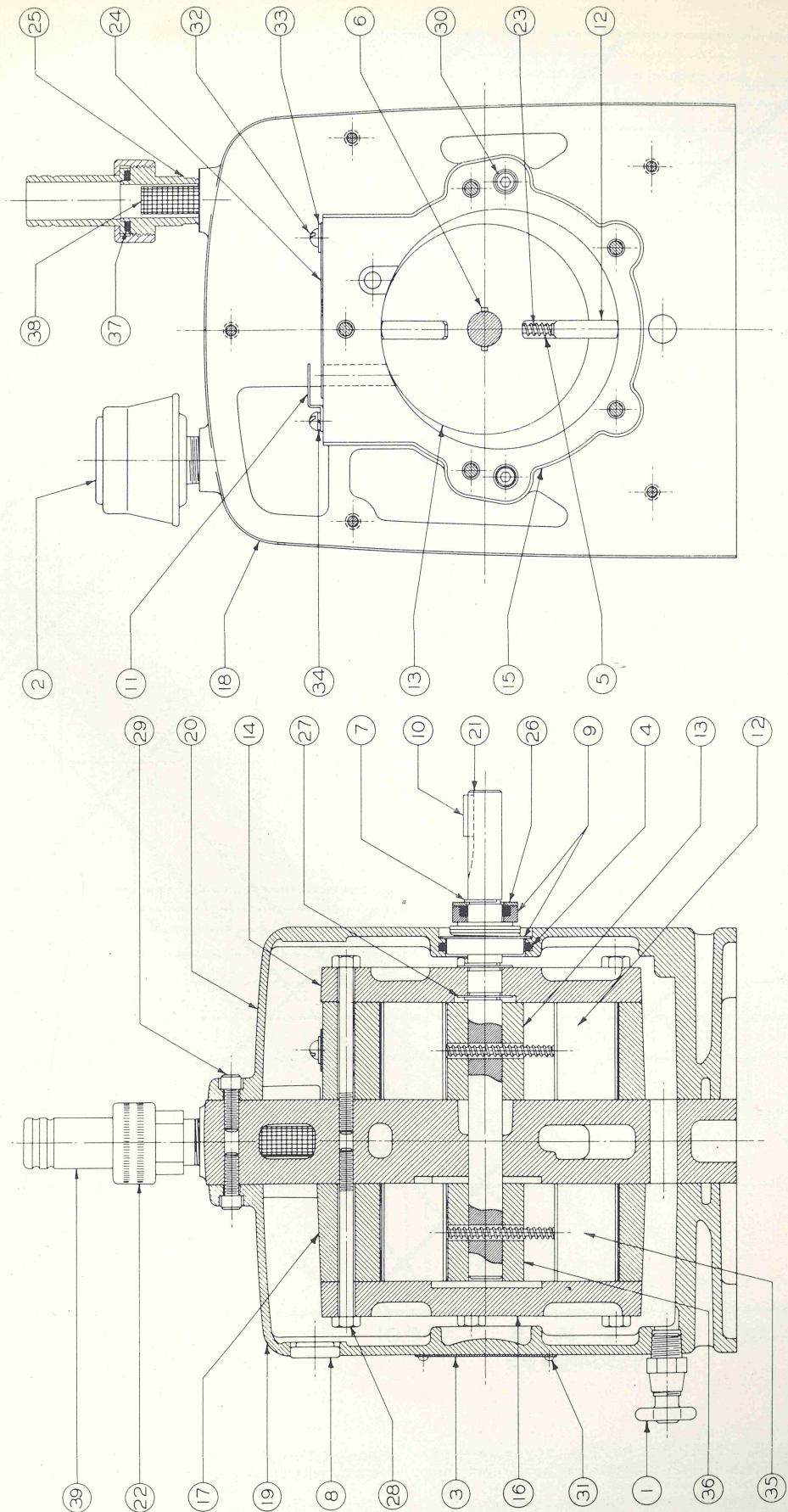
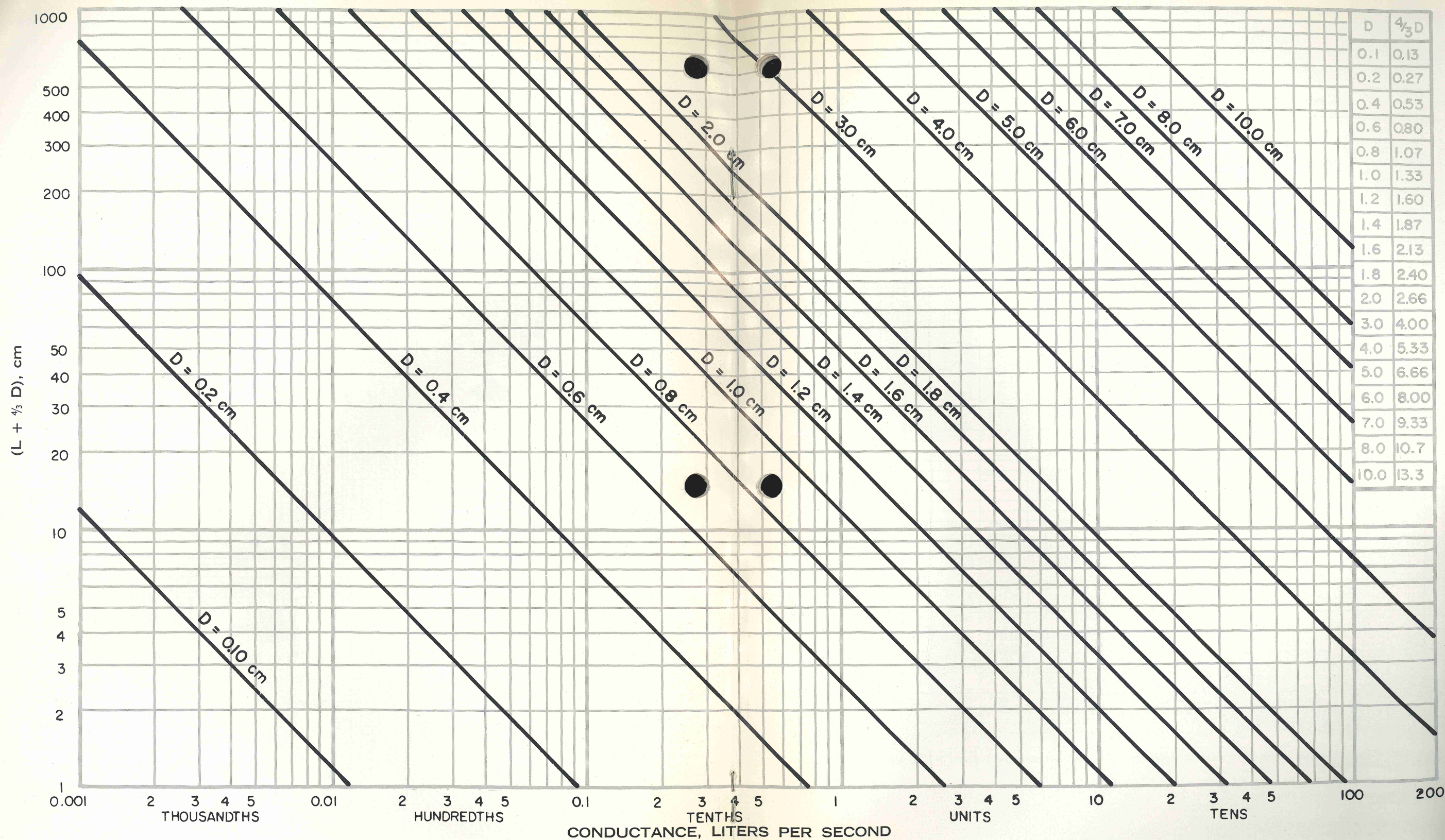


Fig. 5—Sectional view of the Hyvac 2, 4, 6, 7, and 14 Pumps

Fig. 6—Relationship between tubing dimensions and tubing conductance



TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently, the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain a pumping speed (S) as large as possible, the tube conductance (Z) must be very large when compared with the speed of the pump (S_1). This is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} S_1$$

Since at best S is only a fraction of S_1 , the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance (Z), shown in liters/sec., is plotted as abscissas against the quantity $(L + \frac{4}{3}D)$ in cm, as ordinates. In addition to the parameter D , the value of $\frac{4}{3}D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm long, having a diameter of 2 cm, is required. As it can be seen from the table, for $D = 2$, the value of $\frac{4}{3}D = 2.66$ cm. Referring to the curve, for $D = 2$ the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines spaced logarithmically, conductance of tubes having diameters other than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely $\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$ where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

Table IV
REPLACEMENT PARTS

SYMBOL	PART NAME	NUMBER REQUIRED PER PUMP	PART NUMBER							
			Hyvac 2	Hyvac 4	Hyvac 6	Hyvac 7	Hyvac 14	Hyvac 28	Hyvac 45	
1	Drain Cock	1	P13116	P13116	P13116	P13116	P13116	P13116	P13116	
2	Exhaust Dome	1	P35352	P35345	P35345	P35345	P35341	P35617	P35617	
3	Direction Plate	1	P25220	P25252	P25252	P25252	P25212	P25329	P25348	
4	"O" Ring, Shaft Seal	1	P27080	P27080	P27080	P27080	P27082	P27082	P27082	
5	Vane Spring	2	P28066	P28065	P28065	P28065	P28064	P28064	P28064	
6	Shaft Key	3	P29313	P29313	P29313	P29313	P29313	P29313	P29313	
7	Crescent Truarc Ring	3	P29260	P29260	P29260	P29260	P29187	P29187	P29187	
8	Oil Level	1	P35291	P35291	P35291	P35291	P35291	P35291	P35291	
9	Shaft Seal	1	P35332 ¹	P35332 ¹	P35332 ¹	P35332 ¹	P35334 ²	P35334 ²	P35334 ²	
10	Housing Gasket	2	91310-2	91310-7	91310-7	91310-7	91310-14	91310-14	91310-14	
11	Valve Limiter	1	P60827	P61018	P61018	P61018	P61018	P61018	P61018	
12	Exhaust Vane	2	P60787	P60776	P60776	P60776	P60765	P60765	P60765	
13	Exhaust Rotor	1	P60788	P60777	P60777	P60777	P60766	P60766	P60766	
14	Exhaust End Plate	1	P60789	P60778	P60778	P60778	P60767	P60767	P60767	
15	Exhaust Stator	1	P60790	P60779	P60779	P60779	P60768	P60768	P60768	
16	Intake End Plate	1	P60791	P60780	P60780	P60780	P60769	P60769	P61143	
17	Intake Stator	1	P60792	P60781	P60781	P60781	P60770	P60770	P60770	
18	Center Plate	1	P60793	P60782	P60782	P60782	P60771	P61131	P61151	
19	Drain Housing	1	P60794	P60783	P60783	P60783	P60772	P61118	P61118	
20	Seal Housing	1	P60795	P60784	P60784	P60784	P60773	P60773	P61150	
21	Shaft	1	P60797	P60786	P60786	P60786	P60775	P61129	P61144	
22	Vacuum Coupling Nut	1	---	P63516	P63516	P63516	P63519	---	---	
23	Spring Pin	2	P63503	P63501	P63501	P63501	P63499	P63499	P63499	
24	Flutter Valve	1	P65471	P65470	P65470	P65470	P65532	P65532	P65532	
25	Coupling Adapter	1	---	P63545	P63545	P63545	P63546	---	---	
26	Thrust Washer	1	P78031	P78031	P78031	P78031	P78032	P78032	P78032	
27	Thrust Washer	2	P78034	P78034	P78034	P78034	P78033	P78033	P78033	
28	1/4-20 x 2-1/4 Hex. Hd. Steel Screw	10	P29315	---	---	---	---	---	---	
28	1/4-20 x 3 Hex.Hd.Steel Screw	10	---	P29316	P29316	P29316	---	---	---	
28	5/16-18 x 3-1/2 Hex.Hd.Steel Screw	10	---	---	---	---	P29317	P29317 ³	---	
29	1/4-20 x 3/4 Soc. Hd. Steel Screw	10	---	---	---	---	---	---	---	
29	5/16-18 x 1 Soc. Hd. Steel Screw	14	---	---	---	---	---	---	---	
30	1/4-20 x 1 Soc. Hd. Steel Screw	4	---	---	---	---	---	---	---	
30	1/4-20 x 1-3/4 Soc. Hd. Steel Screw	4	---	---	---	---	---	---	---	
30	5/16-18 x 2 Soc. Hd Steel Screw	8	---	---	---	---	---	---	---	
31	No. 2 x 5/16 Rd. Hd. Drive Screw	4	---	---	---	---	---	---	---	
32	10-24 x 1/4 Rd. Hd. Steel Screw	2	---	---	---	---	---	---	---	
33	No. 10 Bright Steel Burr	1	---	---	---	---	---	---	---	
34	No. 10 Split Lock Washer	1	---	---	---	---	---	---	---	
35	Intake Vane	2	P60787	P60776	P60776	P60776	P60765	P60765	P60765	
36	Intake Rotor	1	P60788	P60777	P60777	P60777	P60766	P60766	P60766	
37	"O" Ring, Coupling	1	---	94236-4	94236-4	94236-4	94236-5	---	---	
38	Intake Screen	1	P29295	P29296	P29296	P29296	P29297	P29492	P29513	
39	Coupling Hose Nipple	1	---	P63556	P63556	P63556	P63558	---	---	
40	Hose Nipple	1	P69263	---	---	---	---	P63764	P63765	
43	Gas Ballast Valve	1	P67416	P67416	P67416	P67416	P67416	P67416	P67416	
44	Gas Ballast Valve Knob	1	P26139	P26139	P26139	P26139	P26139	P26139	P26139	
45	Belt	1	P27185 ⁴	P27113	P27114 ⁵	P27114 ⁵	P27113	P27113	P27113	
46	Valve Limiter	3	---	P61108	P61108	P61108	P61108	P61108	P61108	
47	5/16-18 x 6-1/4 Hex. Hd. Stl.Cap Screw	5	---	---	---	---	---	P29553	P29553	
48	Gas Ballast Grommet	1	P27120	P27120	P27120	P27120	P27120	P27120	P27120	
49	Relief Valve Ball	3	---	P29012	P29012	P29012	P29514	P29514	P29514	
50	Intermediate Plate	1	---	---	---	---	---	P61119	P61153	
51	Exhaust Side Intermediate Plate No. 1	1	---	---	---	---	---	---	P61148	
52	Exhaust Side Intermediate Plate No. 2	1	---	---	---	---	---	---	P61149	
53	Exhaust Side Intake Stator	1	---	---	---	---	---	---	P61152	
54	Pump Pulley	1	P35460	P29559	P29491	P29491	P29273	P29273	P29273	
55	Transfer	1	P35239	P35239	P35239	P35239	P35239	P35239	P35239	
56	Exhaust Baffle	1	---	---	---	---	P65767	---	---	
57	5/16-18 x 6-1/2 Hex. Hd.Stl.Cap Screw	5	---	---	---	---	---	---	P29458	

All items are illustrated except those numbered higher than 40 in the upper photo and Nos. 45, 54, 55, and 56 in the lower photo.

¹Replacement for Shaft Seal No. P35332 only:
Floating Seat Back-up Ring No. P27205
"O" Ring No. P27080

²Replacement for Shaft Seal No. P35334 only:
Floating Seat Back-up Ring No. P27206
"O" Ring No. P27082

³Hyvac 28 requires only 5 screws No. P29317

⁴Belt No. P27111 is used on pumps below Serial No. 4000

⁵Belt No. P27112 is used on pumps below Serial No. 3000

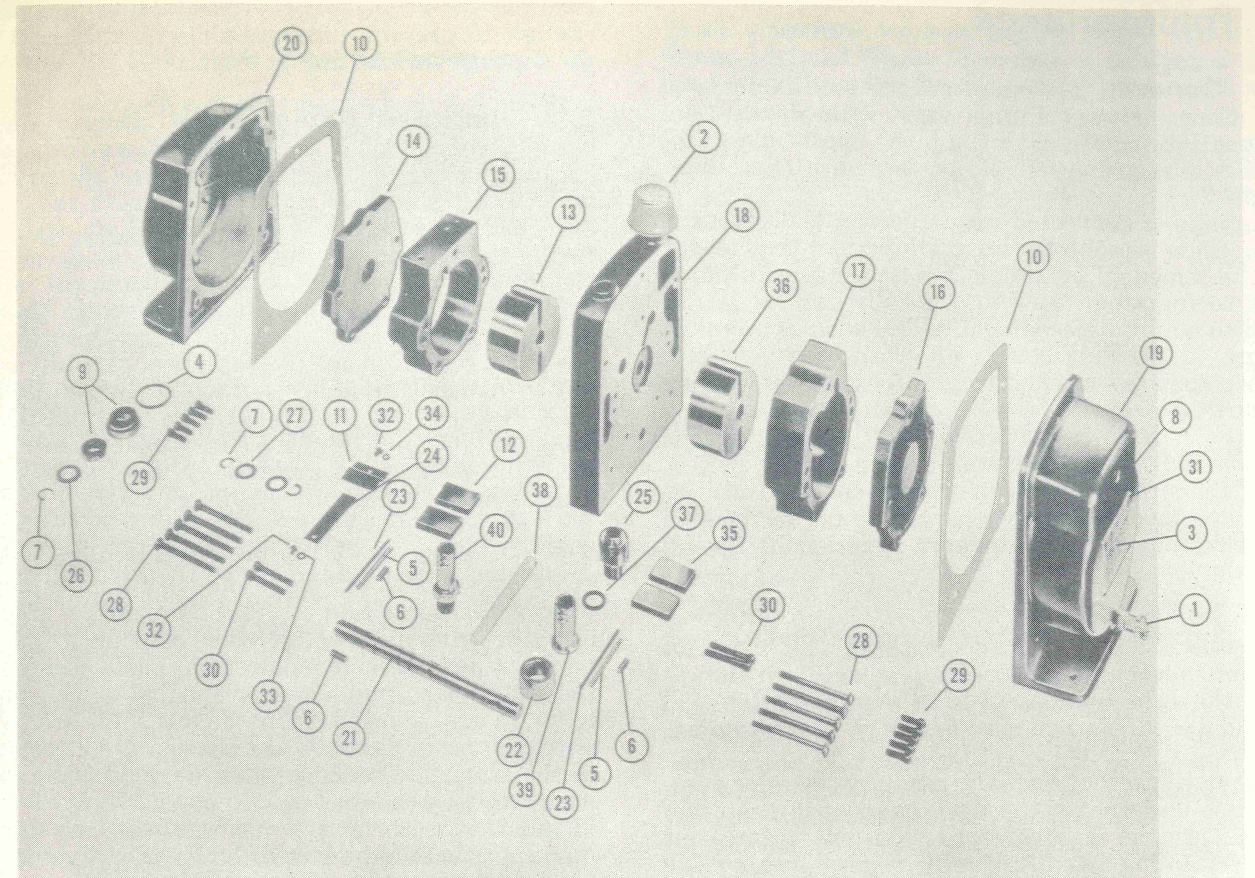


Fig. 7—Exploded view of the Hyvac 2, 4, 6, 7, and 14 Pumps

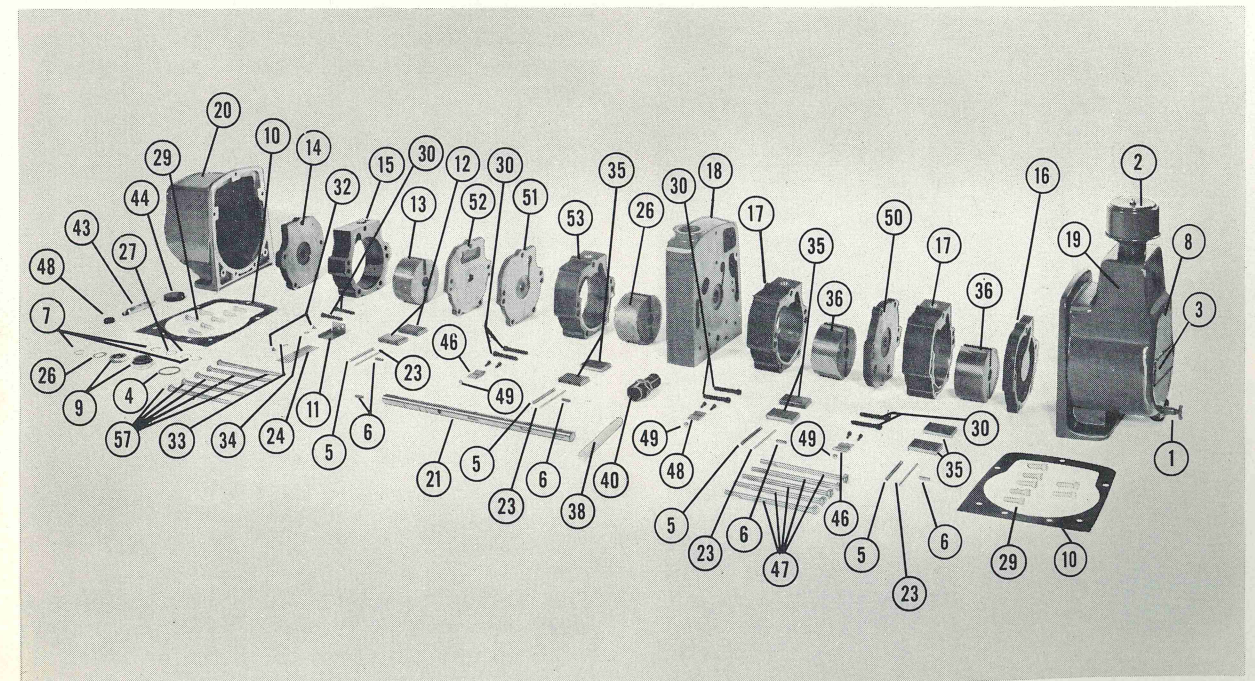


Fig. 8—Exploded view of the Hyvac 45 Pump

7 maintenance

7.1 General: The maintenance requirements of the Cenco Hyvac Pump vary with application. Proper lubrication is one of the most important factors in securing reliable performance (See Paragraph 7.2).

If a pump is connected into a normal leak-free system, there should be no malfunction that might not be remedied by simple adjustments. If a pump fails to function, the cause usually can be attributed to a minor mechanical failure such as a broken spring, a sticking vane, or worn valve release, rather than to misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal operation, where no corrosive vapors are encountered, there will be no decrease in the efficiency of a pump over a period of several years.

7.2 Oil Change: A decrease in the value of maximum vacuum attainable is usually an indication that the oil has become contaminated. Oil should be changed at the first sign of contamination.

To remove the oil, stop the pump, place a large receptacle underneath the drain, and open the drain cock. Turn the shaft several revolutions to force out any remaining oil. Flush with clean Flushing Oil, No. 93060, at least once and then refill with new Hyvac Oil No. 93050.



Hovac Oil, Cenco Nos. 93050 and 93055, and Hyvac Flushing Oil, Cenco No. 93060

The frequency of oil change is dependent upon the use of the pump. An oil change may be needed only once in six months if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosive or highly condensable vapors enter the pump.

When the pump is operated continuously, the oil temperature may reach 50° to 60°C. This temperature is normal for efficient operation of the pump.

7.3 Belt Adjustment: The belt in mounted pumps can be adjusted by loosening the bolts in the base of the motor and moving the motor in the

required direction. The belt should be just tight enough to prevent slippage while operating. A little slippage on starting is desirable.

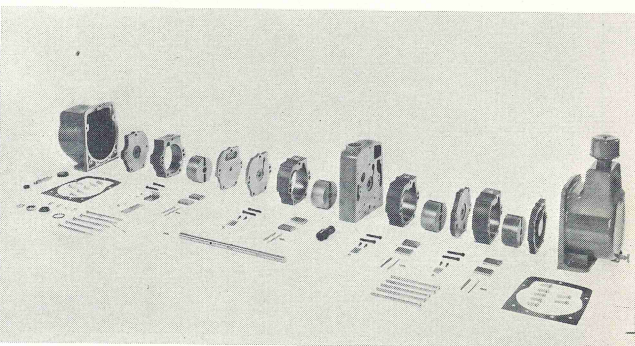
7.4 Shaft Seal Replacement: The seal on the pump shaft, symbol 21 in Fig. 5, consists of a "Truarc" ring, (7), a thrust washer (26), a shaft seal (9), and an "O" ring, (4). Remove the "Truarc" ring, the thrust washer, the shaft seal, and finally the "O" ring, in this order.

Before assembling or making a replacement, apply a thin film of pump oil to the pump shaft. Also apply the same amount of oil to the inner surface of the shaft seal. Replace the shaft seal carefully so as not to damage the inner surface of the rubber seal ring. Push the seal back into the cavity until it contacts the "O" ring. Replace the thrust washer, and force the washer and spring over the groove in the shaft. Finally, replace the "Truarc" ring.

7.5 Repairs: Fig. 5 shows cross sectional views of the Hyvac Pump. Figs. 7 and 8 show an exploded view of the pump and all its components. Table IV lists the part number for each component of the pump. When ordering replacement parts, please give the exact part number. For repairs to the pump other than the replacement of the shaft seal, it is strongly recommended that the pump be returned to the factory, especially when adequate shop facilities are not available.

If operated according to instructions, any Hyvac pump will provide years of satisfactory service. If trouble develops, turn off the pump at once.

Only a qualified technician who has available the finest machine shop facilities should attempt to service the pump, using the drawings and charts provided. If the difficulty cannot be corrected immediately, contact your nearest Cenco Branch office or the Service Department, giving all symptoms of the malfunction and wait for further instructions. *Do not return the pump or any of its components without written authorization from Cenco.*



Typical Hyvac Pump disassembled for servicing

The techniques used in the manufacture of Cenco pumps assure interchangeability of parts from pump to pump and eliminate the need for selective parts fitting. This permits users to service or repair pumps on the spot without the need of special tools and equipment or highly-trained personnel. Parts are stocked in Cenco's coast-to-coast warehouse system and are immediately available to users everywhere. In addition, Cenco offers regular factory repair service at its main plant.

8 accessories

Cenco McLeod Gage, Double Range

For all measurements of pressure from 0.5 millitorr to 1600 millitorr. One range reads in millitorr from 0.5 to about 200 or 250; the other to about 1.6 torr. Over-all height is 165 cm. The amount of mercury required is about 10 pounds. Weight, without mercury, 30 pounds.

No. 94151, without mercury

Cenco McLeod Gage, Improved Design Double Range

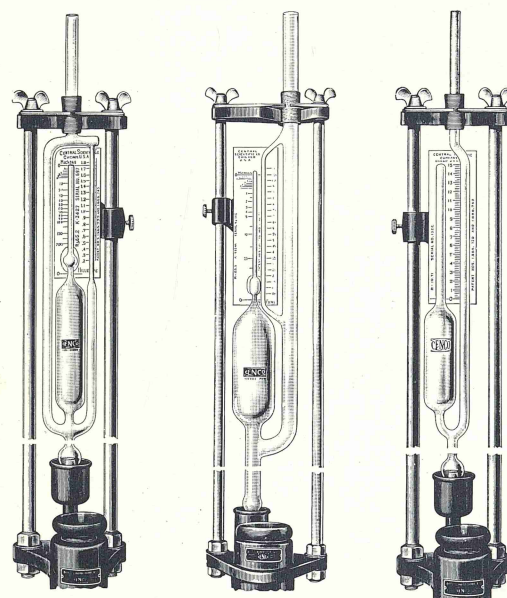
Similar to the No. 94151 but for pressures from about 0.005 to 1000 millitorr. Double range, with one scale reading to approximately 25 millitorr and the other to approximately 1000 millitorr. This gage is intended for use in a system being exhausted by means of a diffusion or a molecular pump. It is made with replaceable precision-bore tubing. This gage requires about 30 pounds of mercury for operation. Over-all height is about 190 cm; weight, without mercury, is about 45 lbs.

No. 94156, without mercury

Cenco McLeod Gage, Single Range

Similar to No. 94151 McLeod Gage, but with single range from 0 to 15 torr, reading to 0.1 torr. Scale magnification by the McLeod principle is about 10. For accurate measurement of gas pressures in the filling of discharge tubes and in measurements of pressure in industrial processes. About 10 lbs. of mercury are required.

No. 94160, without mercury



94151

94156

94160

Cenco measuring heads for the 94151, 94156, and 94160 McLeod Gages.

Cenco Mercury for McLeod Gages

CP, ACS, Triple distilled quicksilver.

1 pound, bottle

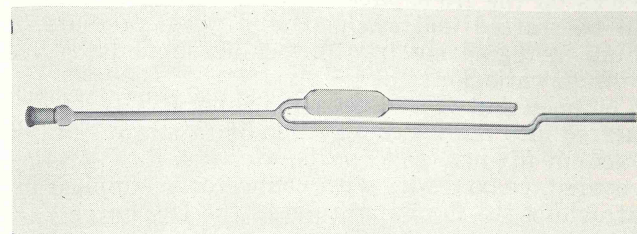
5 pound, bottle

15 pounds maximum quantity for parcel post shipment.

McLeod Gage Glassware

Extra glassware for Nos. 94151, 94156 and 94160 Cenco McLeod Gages. Consists of calibrated glass head with interchangeable ground joint and a calibrated scale.

Cenco No.	McLeod Gage No.	O.D. Connecting Tube
94165-3	94160	10 mm
94165-4	94156	18-19 mm
94165-5	94151	10 mm



Cenco Thermocouple Vacuum Gage

Measures pressures in the range of 1 to 1000 millitorr and reads directly on a single meter scale. Adjusted and calibrated for immediate use, this lightweight gage responds to both condensable and non-condensable gases. The all-metal thermocouple tube resists contamination, physical shock and may be operated at atmospheric pressure. The gage tube has a standard 1/8" NPT male thread, is 5 1/4" long and 1" in diameter. A 5-foot, plastic covered, 4-wire cable with octal socket is supplied for connecting the thermocouple tube to the Thermocouple Gage supply. A separate meter is not required for the heater current. A constant voltage transformer accommodates line voltage variations. The unit is 10 1/4" long, 6 1/2" high and 5 1/2" deep. Attractively finished in blue and beige enamel. Available for operation from either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Supplied with a 3-wire cord and plug for positive electrical connections. Shipping weight is 12 pounds.

No. 94178-1, 115 volt, 60 cycle, ac

No. 94178-8, 230 volt, 50 cycle, ac



Cenco Discharge Gage

Continuous and direct pressure readings from all condensable vapors and permanent gases present in a vacuum system are indicated on a single meter scale. Measures vacuum continuously from 0.001 millitorr to 20 millitorr. The calibration is standardized with a McLeod Gage using dry air. The Discharge Vacuum Gage includes a transistorized dc amplifier and relay to operate auxiliary equipment such as pumps, heaters, etc., at any desired pressure on the scale. Both normally-open and normally-closed contacts are provided through banana jacks on the front panel, permitting the apparatus to be started and stopped at a given pressure. A built-in regulating transformer accommodates line voltage variations.

The open end of the discharge tube, 1" OD, is connected into the vacuum system by means of suitable vacuum fittings, gage ports, etc. A 6-foot, plastic-covered, coaxial wire with connector is supplied for attaching the discharge tube to the Discharge Vacuum Gage.



The Discharge Gage is 16 1/4" long, 7 1/2" high and 6 3/4" deep. Attractively finished in blue and beige enamel. Available for either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Relay contacts are rated for 1 ampere. For heavier loads, a No. 99720-1 or 99725 relay may be used. Supplied with a 3-wire line cord and plug for ground connections. Shipping weight is 15 pounds.

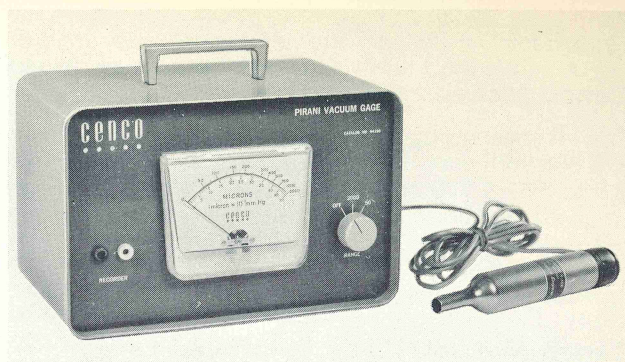
No. 94183-1, 115 volt, 60 cycle, ac
No. 94183-8, 230 volt, 50 cycle, ac

Discharge Tube

A cold-cathode glow-discharge type for replacement in No. 94183 Discharge Gage.
No. 94187

Cenco Pirani Gage

The Cenco Pirani Vacuum Gage, a thermal conductivity type, is based on the temperature and/or resistance change of a heated filament. This change or unbalance is measured on a conventional wheatstone bridge circuit. One arm of the bridge utilizes a compensating tube, sealed under vacuum, to make the circuit insensitive to ambient temperature changes. Pressure is continuously read on a meter having two scales calibrated to the bridge unbalance. One range is 0 to 50 x 10⁻³ torr, and the other is 50 x 10⁻³ torr to 2 torr. The power supply is a full wave bridge rectifier using a constant voltage source. This makes the instrument very stable. Two banana jacks are located on the front panel for recorder use.



Zero drift, which can be a serious problem in Pirani Gages, has been corrected to a great extent by operation of a filament at a much lower temperature (a maximum of 250° C. at a pressure well below 1.0 millitorr) and by inorganic treatment of the filament to provide a stable, inorganic, black surface. The Pirani tube is 7" long with an envelope OD of 1 1/4" and a tubulation OD of 1/2". The Cenco Pirani Vacuum Gage is 10 1/4" long, 6 1/2" high, and 5 1/2" deep. Attractively finished in blue and beige enamel, it is available for 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. The power consumption is 12 watts. Net weight is 8 pounds.

No. 94190-1, 115 volt, 60 cycle
No. 94190-8, 230 volt, 50 cycle

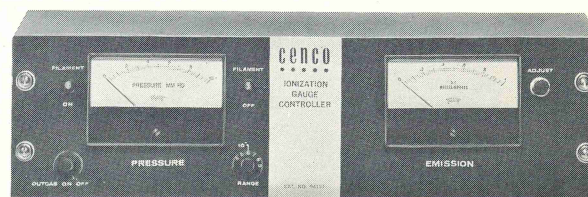
Cenco Ionization Gage

This excellent Ionization Gage incorporates a wide range electrometer amplifier and is designed for use with Bayard-Alpert inverted ionization gage tubes. With it, dry air pressure measurements can be made in the range from 1 x 10⁻³ to 2 x 10⁻¹⁰ torr.

Circuitry

Six separate circuits are used in the Cenco Ionization Gage: a power supply, an electrometer type ion current amplifier, an over-pressure protective circuit, an emission current regulator, a grid outgassing circuit and a recorder output circuit. The amplifier has near 100% negative feedback to provide excellent stability in reading the ion currents from the gage tube collector. The protective circuit controls the filament circuit and, in the event of an overpressure condition, turns the filament off.

The emission regulator is a constant current device with a wide range of adjustments permitting gage tubes with different sensitivities to be used without the need for time-consuming recalibration of the amplifier. The regulator corrects for line voltage fluctuations, pressure changes, and emitter work function changes. The grid outgas circuit supplies current to the grid of the ionization gage tube to bring the grid to a bright red heat for outgassing of the gage tube walls. The recorder output is variable between 0 and 10 millivolts for full scale reading of the pressure meter.

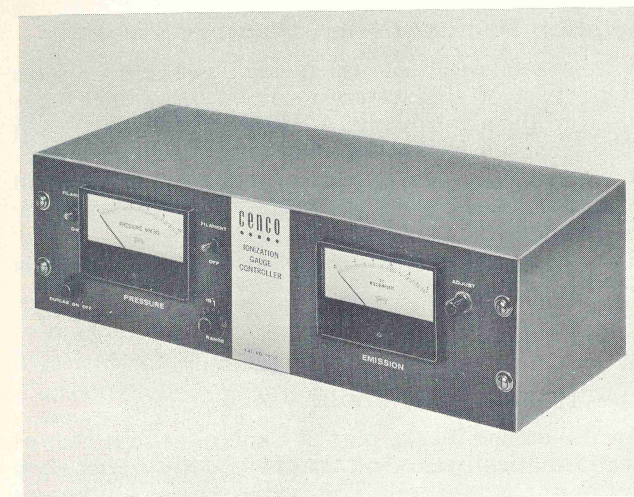


Simplified Control Panel

Controls are grouped for easy reading and use. The pressure gage is calibrated in 100 divisions from 0 to 10. A six decade range switch can be set for readings from 10⁻³ to 10⁻¹⁰. Filament-on-and-off switches have built-in pilot lamps. The outgas circuit switch and emission gage are also mounted on the front panel.

Controller Model

The No. 94198 is provided with a SPDT, 3-ampere, contact meter relay that can be set to turn auxiliary equipment on or off at any pre-set pressure within the range of the gage. A setting control is provided on the front panel.



Specifications

OPERATING RANGE, torr	1 x 10 ⁻³ to 2 x 10 ⁻¹⁰
ZERO DRIFT, % of full scale	2
OVERPRESSURE CIRCUIT, % of full scale	125
OPERATING VOLTAGE	115, 60 cycle
WATTAGE	
Operating	67
Outgassing	110

Gages are supplied with a 3-wire line cord and plug for connection to a power line, a 4-wire gage power cable, and a coaxial cable for ion collection.

No. 94197 without controller
No. 94198 with controller

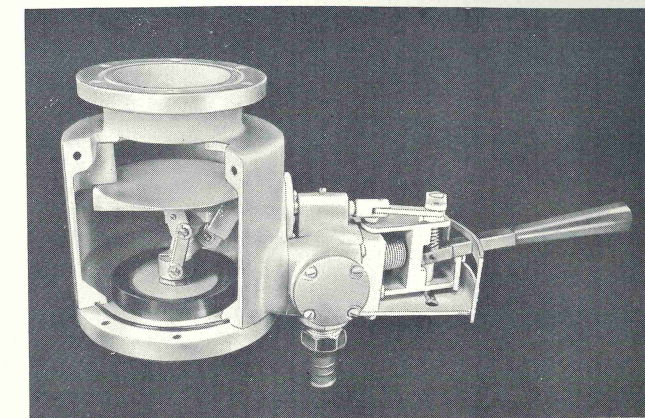
Ionization Gage Tubes

Hot filament tubes for use with the Nos. 94197 and 94198 Ionization Gages. All types utilize the Bayard-Alpert inverted element configuration and are suitable for measuring pressure in the range from 10⁻³ to 10⁻¹⁰ torr. The tubes are provided with three filaments that can be used separately or collectively to allow for both longer tube life and higher gage sensitivity when using higher electron currents to the grid. Tube sensitivity is 60 microamperes per micron when using 5 milliamperes grid current or 100 microamperes when using 8 1/3 ma grid current. Four types are available, three with tubulation enclosed filaments and one with filaments exposed for extremely accurate readings. Connections are provided to outgas the grid structure by passing current through the grid element.

No. 94195-1 With 3/4-inch Nonex tubulation
No. 94195-2 With 3/4-inch Pyrex tubulation
No. 94195-3 With 3/4-inch Kovar tubulation
No. 94196 Without tubulation

Cenco Three-Way Vacuum Valve

Designed to serve as a master control in high vacuum systems employing a diffusion pump and a mechanical pump. It replaces the roughing, foreline and high-vacuum valves now being used in conventional systems. With this valve, the evacuated chamber may be quickly isolated from and connected back into the pumping system without shutting down the pumps. Rapid single lever action facilitates positive mechanical switching to each of three operating positions: "Closed," "Rough Down," and "Diffusion Pump." This direct mechanical movement eliminates problems associated with solenoid operated and hydraulic or pneumatic mechanisms. A water-cooled baffle is included to minimize backstreaming from the diffusion pump. The control lever extends 6" beyond the detent mechanism to provide convenient operation when the valve is mounted beneath a large baseplate or behind a panel.



Flow Passages. All passages provide full pipe area throughout. Throat openings for the main valve are 4 inches in diameter. Passages for the foreline and roughing line are equivalent to 1 inch pipe.

Outgassing. Minimum outgassing time is required as only materials with low-vapor pressure are used for seals. Special attention has also been given in construction to eliminate "virtual leaks."

Vacuum Tightness. The valve body and end plates are cast of close grained aluminum and vacuum impregnated after machining to assure tightness. Metallic bellows are used to seal the two movable links and rubber rings are employed at the fixed joints. The three valve disks consist of metal plates with integrally molded rubber sealing lips.

Connections. Six 1 3/32" diameter holes equally spaced on 5 1/4" diameter bolt circle are provided to attach the valve to a pump plate. To connect a diffusion pump, six 3/8-24 UNF x 1/2" deep holes equally spaced on 5 1/4" diameter bolt circle are provided. Foreline and roughing lines are connected on two nipples for 1" I.D. rubber hose. Connect 90° elbow nipple to diffusion pump outlet and straight nipple to mechanical pump. To connect the water lines, rubber tubing or ordinary 3/8" diameter copper tubing with compression type fittings may be used. The valve cooling coil may be connected in series (but in front of) the cooling coil on the diffusion pump or to an individual water source. Shipping weight is 35 lbs.
No. 94552

HIGH VACUUM EQUIPMENT IS AVAILABLE FROM WAREHOUSES THROUGHOUT NORTH AMERICA FOR PROMPT SERVICE AND DELIVERY

CENTRAL SCIENTIFIC COMPANY

GLOSSARY OF VACUUM TERMINOLOGY

This is a partial list of standard terms used in vacuum technology and is adapted from those prepared by the Standards Committee of the American Vacuum Society.

BACK STREAMING The direct flight of vapor molecules by scattering from the hot vapor jet or evaporation from hot nozzle parts in the direction of the mouth or intake port of a vapor pump.

BAKE-OUT The degassing of a vacuum system by heating in an oven during the pumping process.

CONDUCTANCE (Measured value) The physical measure of a system which describes its ability to accommodate the flow of gas, usually measured in liters per second. Specifically, the throughput under steady state conservative conditions divided by the measured difference in pressure between two specified cross sections inside a pumping system. $C = Q/(P_1 - P_2)$

DEGASSING The deliberate removal of gas from a material, usually by application of heat under high vacuum.

DIFFUSION PUMP A vapor pump having boiler pressures less than a few Torr and capable of pumping gas with full efficiency at intake pressures not exceeding about 20 millitorr and discharge pressures (forepressures) not exceeding about 500 millitorr. The pumping action of each vapor jet occurs by the diffusion of gas molecules through the low-density scattered vapor into the denser forward moving core of a freely expanding vapor jet.

FOREPRESSURE The total pressure on the outlet side of a pump measured near the outlet port.

FORE PUMP The pump which produces the necessary fore vacuum for a pump which is incapable of discharging gases at atmospheric pressure. Sometimes called the backing pump.

FREE AIR DISPLACEMENT The volume of air passed per unit time through a mechanical pump when the pressure on the intake and exhaust sides is equal to atmospheric pressure. Also called free air capacity.

GAS BALLAST PUMP A mechanical pump (usually of the rotary type) equipped with an inlet and

valve through which a suitable quantity of atmospheric air or "dry" gas can be admitted into the compression chamber so as to prevent condensation of vapors within the chamber by maintaining the partial pressure of the vapors below the saturation value. Sometimes called a vented-exhaust mechanical pump.

HOLDING PUMP A fore pump used to hold a vapor pump at efficient operating conditions while a roughing pump reduces the system pressure to a point at which the valve between the vapor pump and the system can be opened without stopping the flow of vapor from the nozzles.

IMPEDANCE The reciprocal of the conductance. Also called resistance. $Z = 1/C$.

LEAK RATE The quantity of gas in pressure-volume units at room temperature flowing into the system or through the pump from an external source in unit time.

LIMITING FOREPRESSURE The forepressure which corresponds to an inlet pressure about 0.2 millitorr greater than the inlet pressure corresponding to the normal forepressure for a vapor pump at a given load (or throughput).

MEASURED SPEED (of pump) The leak rate of gas admitted from a flow measuring device divided by the total pressure measured near the mouth (or inlet port) of a pump with a specified gauge mounted in a specified testing head. $S_m = Lm/P$.

MECHANICAL PUMP A pump which moves the gas by the cyclic motion of a system of mechanical parts such as pistons, eccentric rotors, vanes, valves, etc.

MERIT FACTOR The ratio of the speed of exhaust of a mechanical pump for air at one micron to the free air displacement. $Mf = Sl/Sf$.

MICRON OF Hg A unit of pressure equal to 1×10^{-3} millimeters of Hg. In modern usage it is being replaced by 1×10^{-3} torr or millitorr.

MICROTORR A unit of pressure equal to 10^{-6} Torr.

MILLIMETER OF Hg and its abbreviation mm of Hg is equal to $1/760$ of a standard atmosphere. This term is being replaced by the new international standard unit Torr.

MILLITORR A unit of pressure equal to 10^{-3} Torr.

MOLECULAR FLOW The flow of gas through a duct under conditions such that the mean free path is

greater than the largest dimension of a transverse section of the duct.

OUTGASSING The spontaneous evolution of gas from a material in a vacuum.

ROUGHING PUMP The pump used to reduce the system pressure to the point at which a vapor pump (or other pump requiring a fore vacuum) can take hold and operate efficiently.

SPEED The speed of a pump for a given gas is the ratio of the throughput of that gas to the partial pressure of that gas at a specified point near the mouth (or inlet port) of a pump. $S = Q/P$.

SPEED OF EXHAUST The magnitude of the rate of reduction of pressure in the system multiplied by the volume and divided by the measured pressure.

THROUGHPUT The quantity of gas in pressure-volume units at a specified temperature flowing per unit time across a specified open cross section of a pump or pipe line.

TORR Suggested international standard term to replace the English term millimeter of mercury and its abbreviation mm of Hg. The Torr is defined as $1/760$ of a standard atmosphere.

ULTIMATE PRESSURE The limiting pressure approached in the vacuum system.

VACUUM

ROUGH VACUUM: 760 to 1 Torr (Torr range)
FINE VACUUM: 1 to 10^{-3} Torr (millitorr range)

HIGH VACUUM: 10^{-3} to 10^{-6} Torr (microtorr range)

VERY HIGH VACUUM: 10^{-6} to 10^{-9} Torr (nanotorr range)

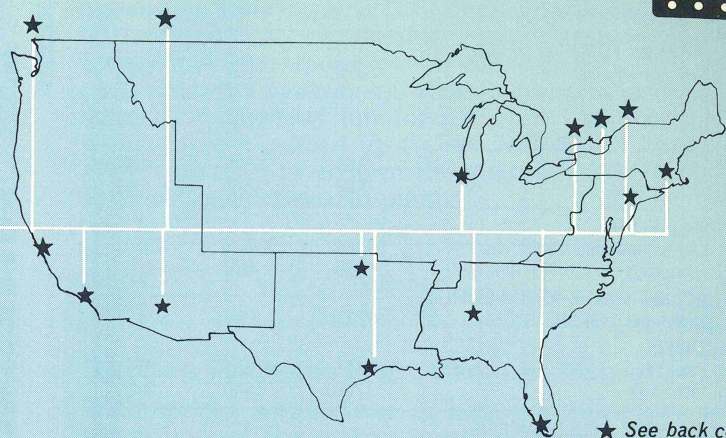
ULTRA-HIGH VACUUM: 10^{-9} Torr and below

VISCOUS FLOW The flow of gas through a duct under conditions such that the mean free path is very small in comparison with the smallest dimension of a transverse section of the duct.

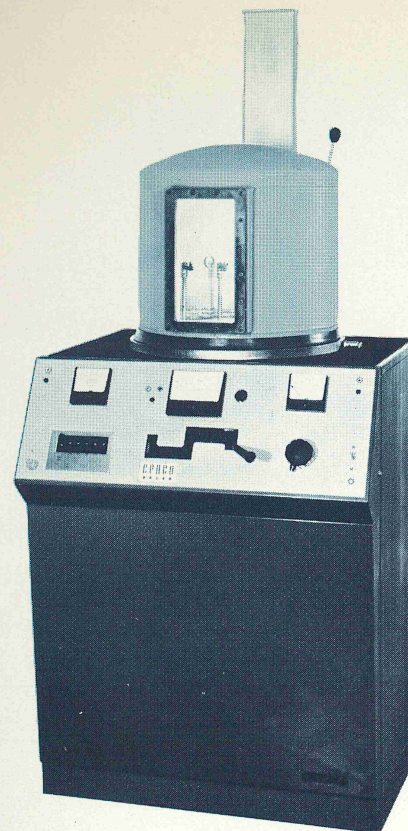
CONVERSION MULTIPLIERS

FROM	TO	MULTIPLIER
LITERS/SEC	CUBIC FT/MIN	2.12
LITERS/MIN	CUBIC FT/MIN	0.0353
LITERS/SEC	LITERS/MIN	60.0
CC/SEC	LITERS/SEC	0.001
CUBIC FT/MIN	LITERS/MIN	28.32

CENCO
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★ See back cover for complete listing of Cenco Branches.



NO. 94700

LABORATORY VACUUM SYSTEM

A light weight, compact unit designed to be used in research laboratories, industrial production and pilot plants, where a completely self-contained unit is required for a wide variety of vacuum applications. This unit is ideal for high vacuum deposition of metals on optical and other surfaces.

A 19-inch diameter pump plate is connected through the Cenco Three-Way Valve to a high speed diffusion pump backed by a Hyvac 14 mechanical pump. The Three-Way Valve replaces the roughing, foreline and high vacuum valves now used in conventional systems. The quick mechanical movement of its single lever operation eliminates the lack of reliability and high cost associated with pneumatic and solenoid operated valves. It also prevents costly errors due to operating valves in the wrong sequence. A built in water-cooled baffle minimizes backstreaming from the diffusion pump.

The bell jar can be evacuated within five minutes to a working vacuum of 1 micron of mercury as read on the vacuum discharge gage connected to the pump plate. A few more minutes of pumping will attain 0.1 micron—excellent for evaporation. The system is also equipped with a thermocouple gage which gives the foreline pressure to the operator, thereby indicating when to switch in the diffusion pump.

The implosion proof, aluminum alloy bell jar offers full visibility of the chamber interior through a large plastic window. The bell jar is raised by a self-contained spring-loaded hoist to quickly expose the pump plate and its nine electrodes. Twelve volts ac at 100 amperes are available at two pairs of electrodes. Four other electrodes are connected to external jacks on the front panel. They extend the versatility of the system by permitting electrical measurements of phenomena to be made from outside the bell jar or power to be introduced to operate rotating sectors or other devices in the vacuum chamber. The remaining electrode will maintain a glow discharge by a self-contained 5000 v power supply to clean objects before coating.

All prices F.O.B. our nearest branch as of publication date. Applicable taxes will be added. Exact current prices available on request. Terms: 30 days net.

We have attempted to describe accurately the merchandise listed in this bulletin. Additional information will be gladly given upon request. The company warrants that each item of merchandise sold by it is free from defective workmanship or material upon return of the same to the company office at Chicago, Illinois. This warranty is made in lieu of all other warranties, express or implied, and no other warranty, express or implied, is assumed or will be assumed.

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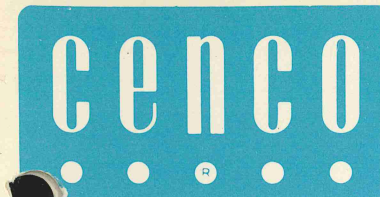
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Cable Address — CENCOINST

EUROPEAN HEADQUARTERS

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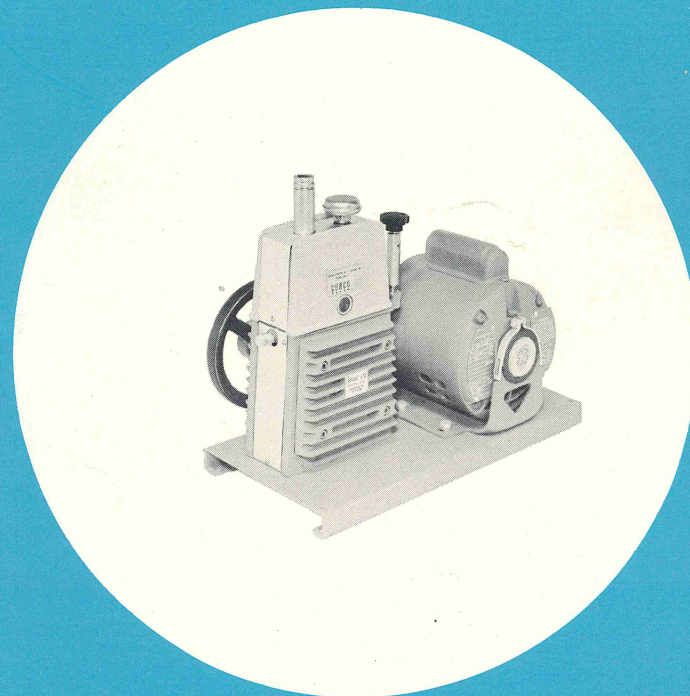


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mechanical vacuum pumps

A COMPLETE LINE OF HIGH VACUUM PUMPS, GAGES, SYSTEMS, & COMPONENTS

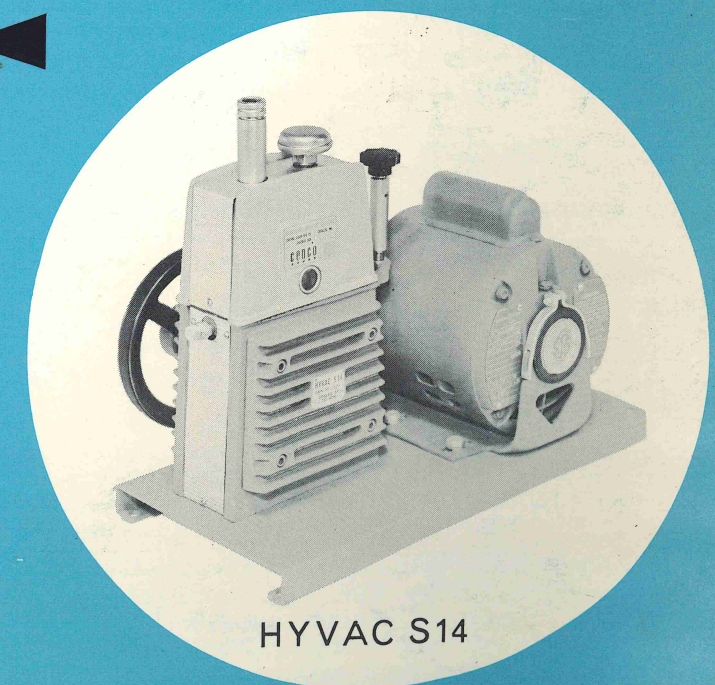
CENCO HYVAC S14 SINGLE STAGE PUMP



A single stage, oil sealed mechanical pump of the internal vane design for use in the factory or lab where high speed is required in backing diffusion pumps. Rated at 140 liters per minute pumping capacity at atmospheric pressure, the S14 will pump down to a guaranteed pressure of 10 microns of mercury. Comes unmounted or with a choice of electric motors mounted on a heavy base plate with a pulley, belt, line cord and 3 prong plug. Model No. 90605-1 comes with the 115/230 volt, 60 cycle motor at a price of

\$225.00

	GUARANTEED VACUUM (microns of mercury)	CAPACITY at atmosphere at 1 micron (liters per min.) (liters per min.)		BOOKLET
Hyvac	0.3	10	5	320
Hyvac 2	0.1	21	9	321
Hyvac 7	0.1	70	30	
Hyvac 14	0.1	140	60	
Hyvac S14	10.0	140	—	322
Megavac	0.1	57	22	323
Hypervac 23	5.0	240	—	324
Hypervac 25	0.1	264	120	
Hypervac 100	0.1	960	660	
Pressovac	15.0	35	—	325
Blower Pump	3 IN. Hg	35	—	326



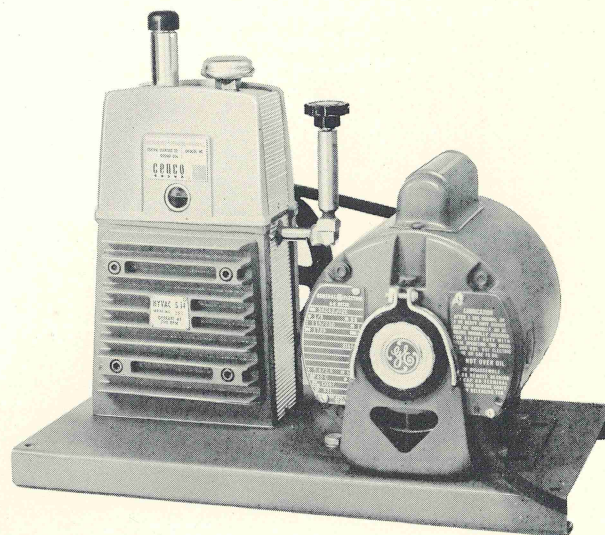
HYVAC S14

CENCO HYVAC S14 SINGLE STAGE PUMP

Booklet 322 operation and maintenance instructions

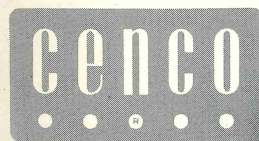
A single stage, oil sealed mechanical pump of the internal vane design for use in the factory or lab where high speed is required in backing diffusion pumps. Rated at 140 liters per minute pumping capacity at atmospheric pressure, the S14 will pump down to a guaranteed pressure of 10 microns of mercury. Comes unmounted or with a choice of electric motors mounted on a heavy base plate with a pulley, belt, line cord and 3 prong plug. Model No. 90605-1 comes with the 115/230 volt, 60 cycle motor at a price of

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manufacturers of instruments for the laboratory sciences

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1 description

1.1 general

Combining quiet, vibrationless operation, high speed and efficiency with low ultimate pressure, the Cenco S14 Single Stage Pump is designed for general purpose high vacuum applications in industry, research and laboratories. It is especially recommended as a backing pump for oil or mercury diffusion pumps or as an economical roughing pump in the complete vacuum system.

The Cenco Hyvac S14 Gas Ballast Vacuum Pump is a single-stage pump utilizing the internal vane principle first adopted by Gaede for vacuum use.

The pump consists of a concentrically driven rotor rotating in a cylindrical chamber, the rotor being offset such that contact is made at the top of the chamber so that a crescent air space is formed throughout the cycle. The intake and exhaust ports are placed on either side of the contacts of the rotor so that as the rotor is driven, a small volume aspirated at the intake port is expanded, cut off, and compressed into the exhaust port.

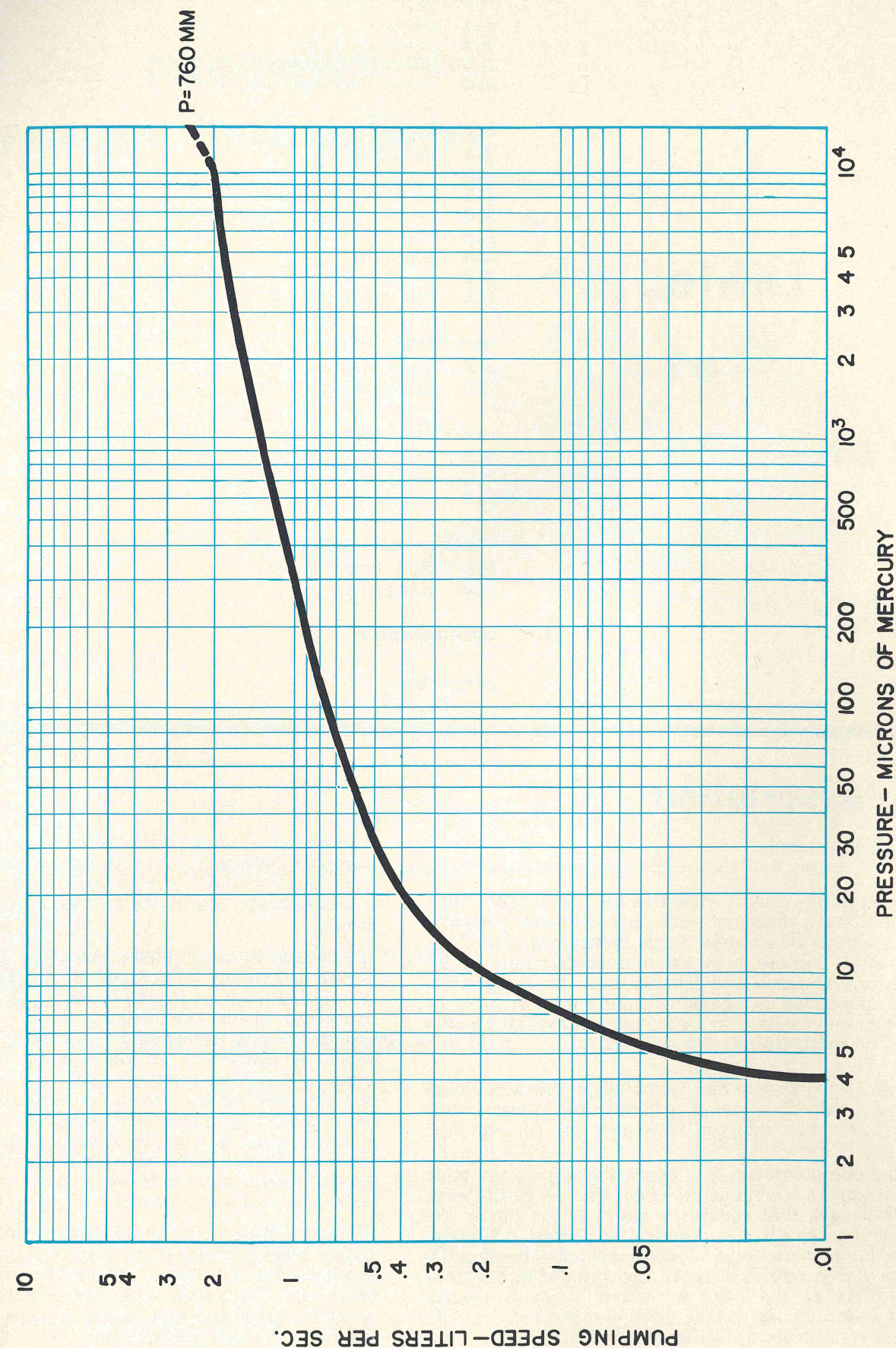
A metered amount of lubricating oil enters the pump through the oil hole in the housing, reducing wear and friction to a minimum and also providing a seal between the intake and exhaust port of the pump.

In contrast to other pumps, the stage of this pump is not completely submerged in oil, therefore the oil requirements are much smaller. Above the stage, contained within the housing (stator), is the oil reservoir which is closed by a cover. The intake nipple is connected to the housing through the cover and the oil reservoir and the exhaust dome is connected to the cover. A seal and rear end plate, sealed by means of O-rings, cover the stage at both sides. A specially designed shaft seal provides a vacuum tight seal on the seal end plate. The oil reservoir in the housing contains an oil level sight gage and a drain cock.

Since the Hyvac S14 Vacuum Pump contains precision machined parts, a high quality, specially compounded lubricator should be used. Cenco Hyvac Oil No. 93050, provided with the pump, is specially processed and should always be used to obtain maximum performance.

SPEED-PRESSURE CURVE FOR CENCO HYVAC S-14 PUMP

GUARANTEED VACUUM=10 MICRONS

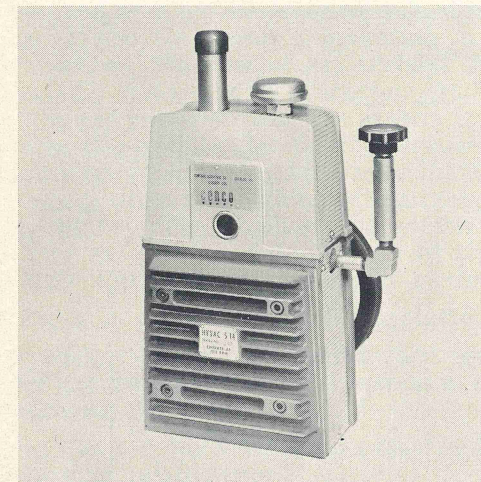


1.2 pump data

The speed pressure characteristics of the Cenco Hyvac S14 Pump are shown in Fig. 1. Additional pump data are as follows:

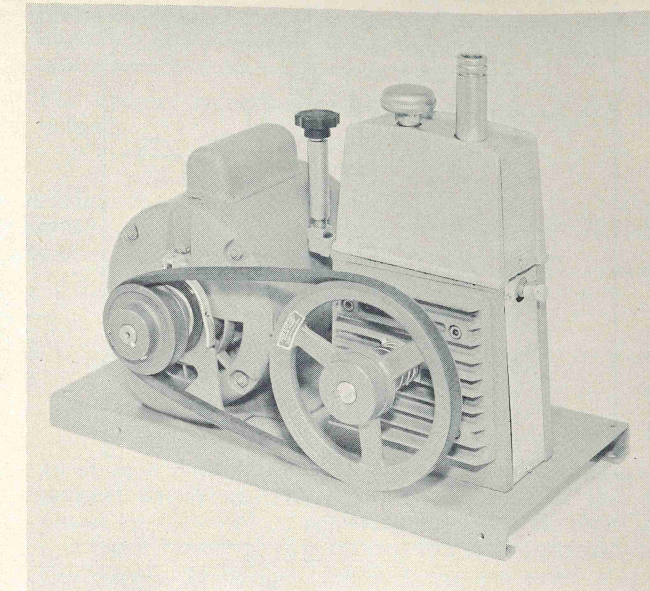
Pump speed (rpm)	750
Capacity at atmospheric pressure (liter/min.)	140
Capacity at 100 microns of mercury)	5
Ultimate vacuum (microns of mercury)	5
Ultimate vacuum with full Gas Ballast (mm of mercury)	2
Guaranteed vacuum (microns of mercury)	10

1.3 unmounted pump



The Hyvac S14 Pump, Cenco No. 90600, is supplied with a grooved pulley only. Four mounting holes, 11/32" diameter on 4 3/4" and 1 1/4" centers are provided on the bottom of the pump.

1.4 pump, mounted with motor



The Hyvac S14 Pump, Cenco No. 90605, is assembled on a steel base and supplied with motor and a belt drive.

CENCO HYVAC S14 SINGLE STAGE PUMP

Cenco Cat. No.	Motor Rating
90605-1	115/230 V., 60 cycle 1 phase, 0.33 hp
90605-7	115/230 V., 50 cycle 1 phase, 0.33 hp
90605-10	115/230 V., 60 cycle 1 phase, 0.33 hp, explosion proof
90605-18	220/440 V., 50/60 cycle 3 phase, 0.33 hp

2 installation

2.1 mounting

If the mounted pump is obtained, the pump is immediately ready for use.

If an unmounted pump is obtained, the pump should be mounted on a flat, rigid, steel or cast-iron base, such as supplied with the mounted unit as shown in Fig. 2. Provisions should be made for bolting the base to the floor or, if used in a movable unit, to the frame. When electronic equipment is

attached to the same frame Shock mounts should be obtained so that vibrations from the motor or pump will not be transmitted through the frame.

A belt drive connects the motor with the pump. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump. The best operating speed is 750 rpm, although a variation in speed of 50 rpm will only change the volumetric speed of the pump. The major dimensions of the pump, pump base and motor are given in Fig. 2.

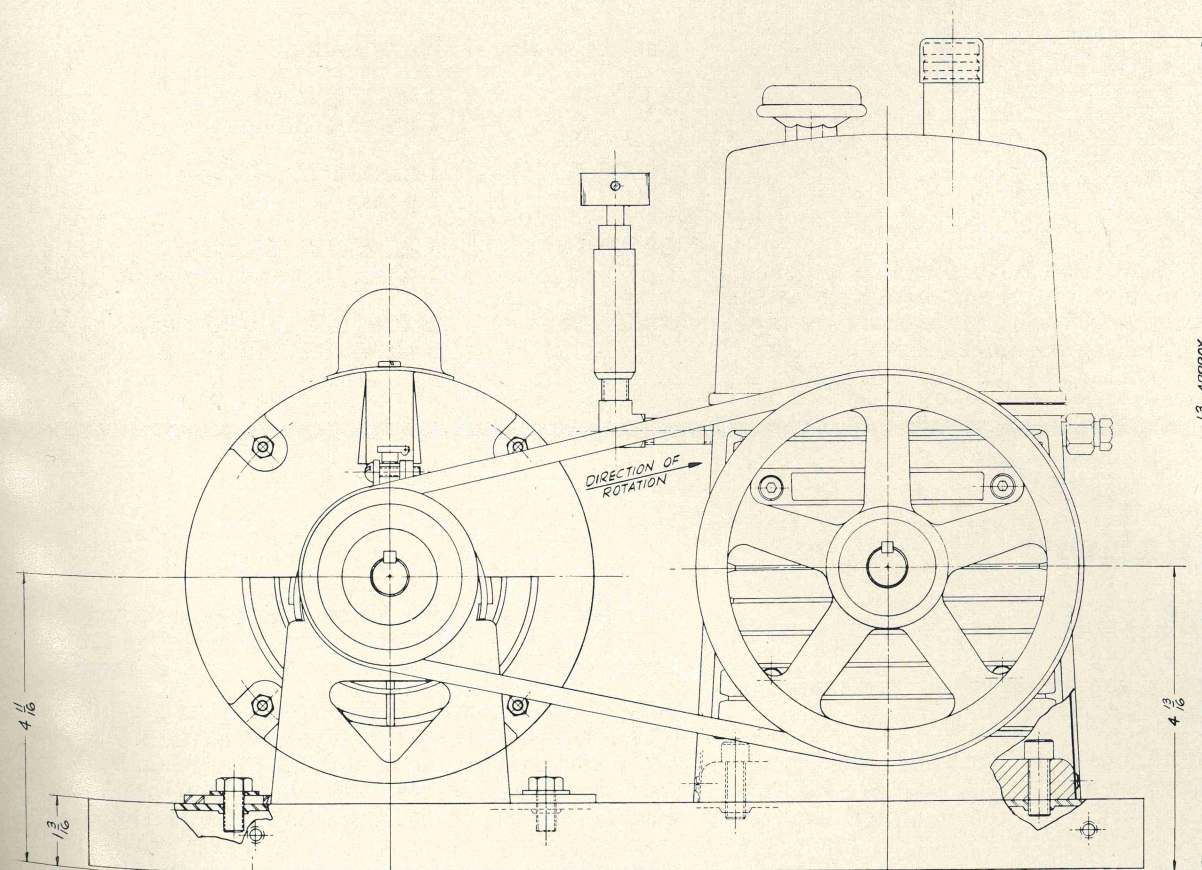
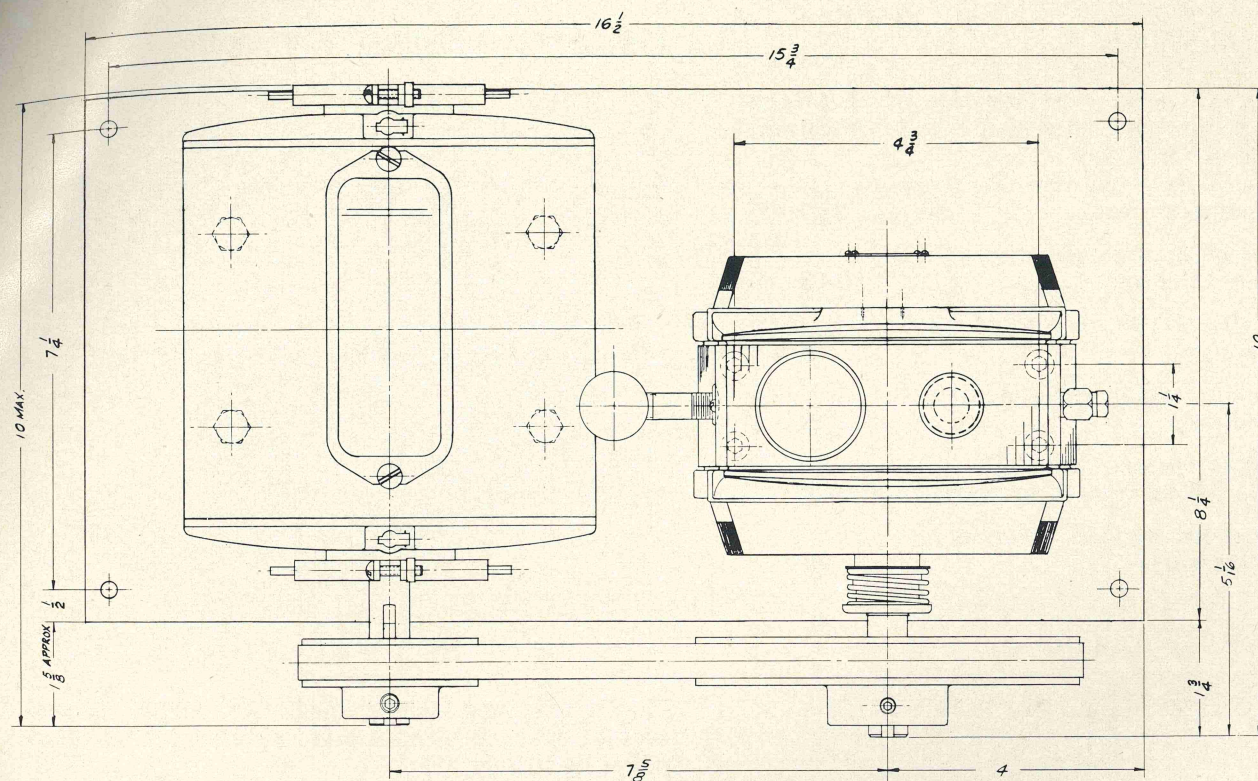


Fig. 2, Outline of S14 Pump

2.2 motor connection

Motors have a connecting 3 conductor grounded cord and plug attached (except Cenco Nos. 90605-10 and 90605-18). In all cases, connect the motor to a powerline of the voltage frequency and phase as indicated on the nameplate of the motor. The powerline should be heavy enough to carry the cur-

rent required without an undue drop in voltage. Two main types of motors are used: (a) single phase, capacitor start type alternating current motors; (b) squirrel cage induction three-phase motors.

For correct selection of the fuse, consult the list below:

Cenco Pump No.	Current at full load (amperes) 115/230 V	Max. fuse rating (amperes) 115/230 V
90605-1	5.6/2.8	20/15
90605-7	6.2/3.1	25/15
90605-10	5.6/2.8	20/15
90605-18	1.6/0.8	15/15

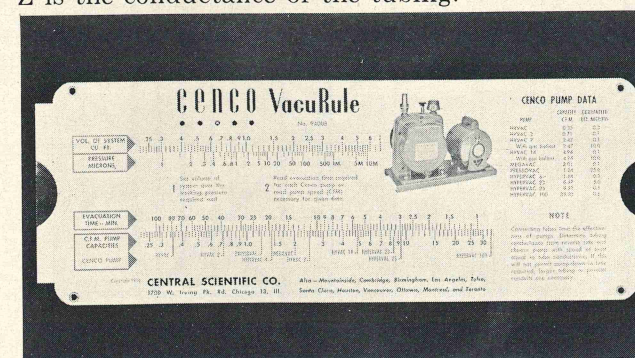
2.3 vacuum connections

When connecting the pump to the system to be evacuated, extreme care must be taken to eliminate leakage. All connections should be as short as possible, and of large diameter to reduce molecular friction. When the pump is operating in the low micron range*, the flow of gas through a tube is substantially molecular in character. At low pressures, the gas removed from the system is confined largely to those molecules which, because of their kinetic energy of agitation, happen to hit the intake of the pump when the cylinder of the pump is open to the intake. The conductance of various size tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008 or may be determined from Fig 3, in which $(L + \frac{8}{3} R)$ is plotted against Z, the conductance in cubic centimeters per second. L and R are the length and inside radii of the tubes in centimeters.

The net speed of the system then may be found by the following relationship:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pump speed taken from Fig. 1 and Z is the conductance of the tubing.

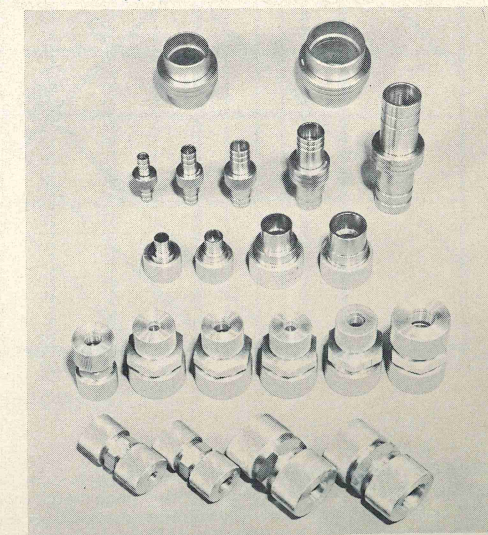


No. 94008 Cenco VacuRule

If metal piping is used, it is best to solder or braze all connections. When threaded pipe joints must be used, the threads should be as perfect as possible. *about 15 to 25 microns at pump port.

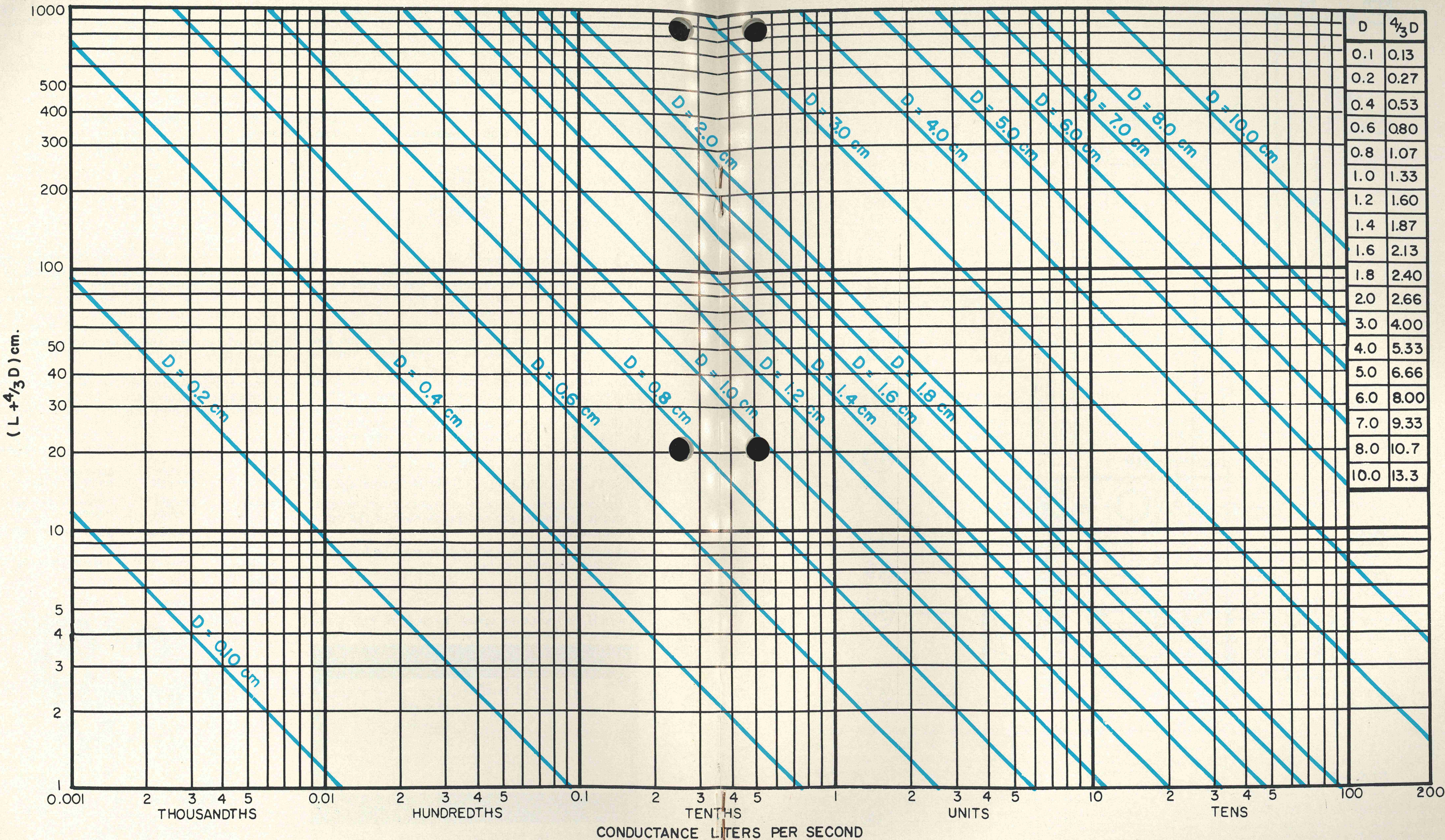
Cenco manufactures an extensive line of couplings, connectors and accessories for use in high vacuum systems (see Cenco Booklet 327). Some of these are:

Cenco No.	Name	For Tubing	Size Range
94226	straight through	glass and/or metal	3/8" - 1"
94235	straight through	metal and/or rubber	1/4" - 2"
94228	reducing	glass and/or metal	3/8" - 1"
94230	connectors	metal-to-glass	3/8" - 1"
94240	caps	for 94235	1/4" - 2"
94245	nipples	rubber	3/8" - 13/16"



Typical Cenco Vacuum Connectors

CONDUCTANCE OF TUBES FOR AIR AT 20°C



TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain pumping speed (S) as large as possible, the tube conductance (Z) must be very large as compared with the speed of the pump (S_1), as is clearly shown by the relation:

$$1/S = 1/S_1 + 1/Z$$

$$S = \frac{Z}{S_1 + Z} \cdot S_1$$

Since at best (S) is only a fraction of (S_1), the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance, (Z), shown in litres/sec, is plotted as abscissas against the quantity ($L + \frac{4}{3}D$), in cm., as ordinates. In addition to the parameter D, the value of $\frac{4}{3}D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the value of the ordinate for a particular tube.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

For example, suppose the conductance of a tube 50 cm. long having a diameter of 2 cm. is required. From the table, for D 2, it is seen the $\frac{4}{3}D = 2.66$ cm. Referring to the curve, for D=2 the conductance corresponding to the ordinate equal to 50 + 2.66, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines, spaced logarithmically, conductance of tubes having other diameters than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely

$$1/Z = 1/b_1 + 1/b_2 + \dots + 1/b_n \quad (3)$$

where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

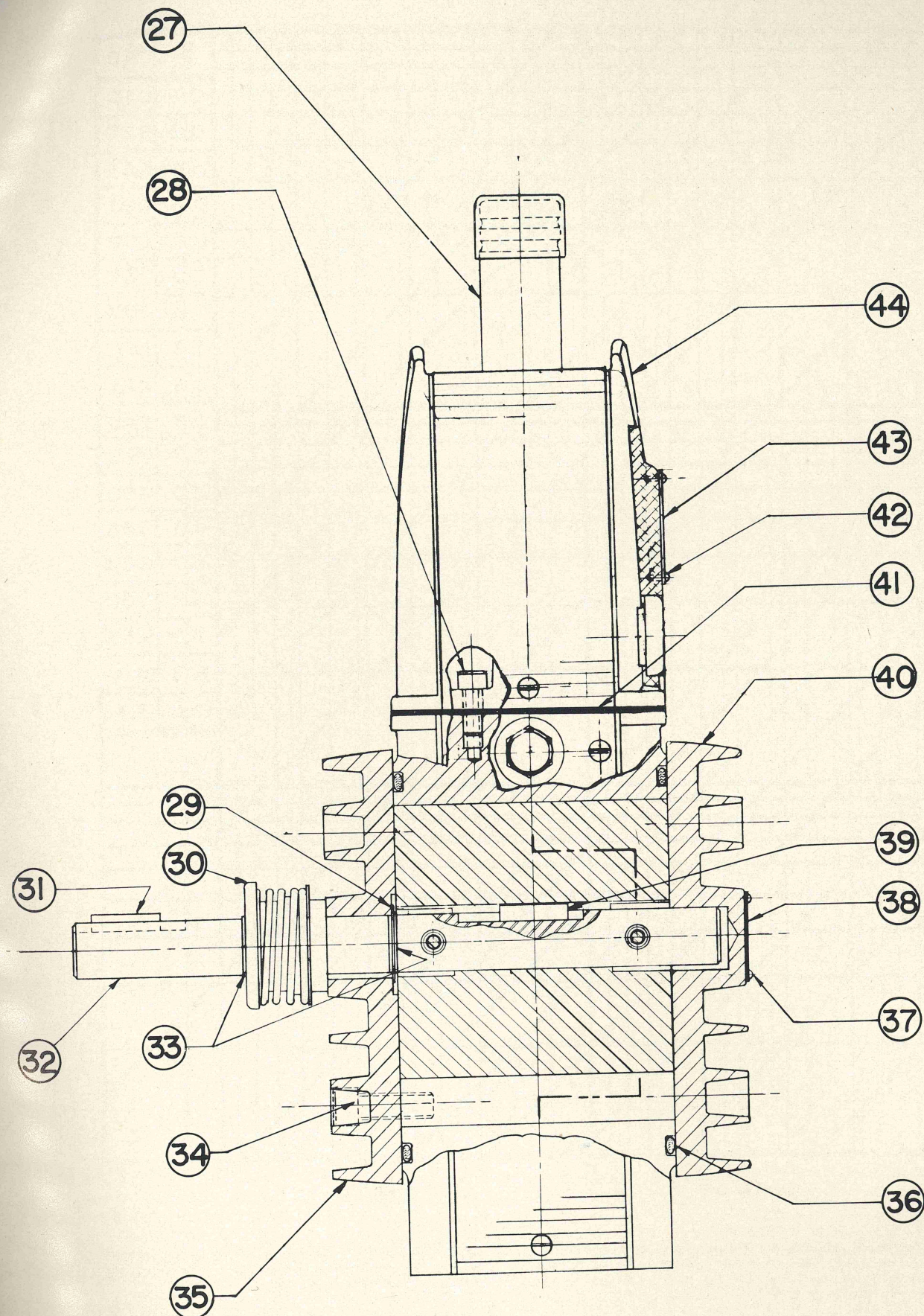


Fig. 4, Sectional View of S14 Pump

The Hyvac S14 pump is provided with a one-piece intake nipple. As supplied, the nipple is intended primarily for use with rubber tubing. When glass connections are used between the pump intake nipple and the system, it is recommended to use a short rubber hose as a coupling between nipple and glass tube.

When tapered glass joints or ball joints are used in connections, a vacuum stopcock grease (No. 15517-1 or No. 15522) should be applied to both members.

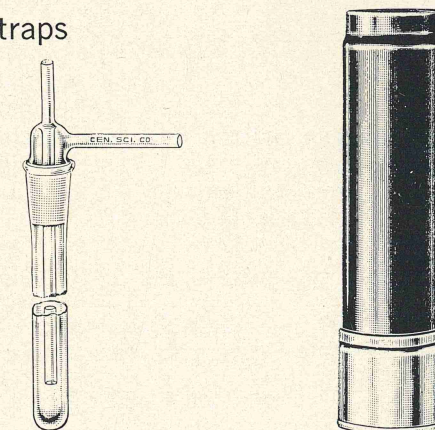
Rubber tubing connections should be kept as short as possible and made with an extra heavy wall, gum tubing, such as No. 18204, which has been compounded specially for vacuum work. All connections to metal or glass tubing should fit snugly and both members should be coated with vacuum stopcock grease.

2.4 valves

Metal vacuum valves and glass stopcocks are employed generally in the connecting line between the pump and the system to provide a means of connecting the vacuum gage and for vacuum release when stopping the pumping. When metal pipes are used for the line, a high-vacuum valve such as No. 94551 is recommended.

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of testing the pump and system for leaks by the "pressure rise" method without disconnecting the pump from the line.

2.5 traps

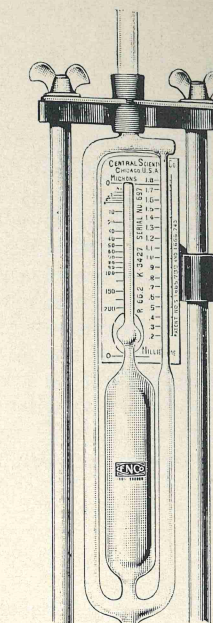


No. 94005 liquid air trap

No. 15230-3 Dewar flask

Extreme care must be taken to prevent solid particles from reaching the intake of the pump. They will score the working parts of the pump and reduce its efficiency. If corrosive vapors are in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor from the pump from entering the system. A Cenco No. 94005 or No. 94006 Glass Trap is recommended. Either should be used in a No. 15820-3 Vacuum Flask. The refrigerant most commonly used in the vacuum flask is a mixture of solid carbon dioxide (dry ice) and acetone or ethyl alcohol.

2.6 gages



No. 91451 McLeod gage

The types of high vacuum gages commonly used in a system employing a Hyvac pump are the McLeod, Pirani, Discharge, and Thermocouple gage. A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0001 mm Hg to 1.6 mm Hg (0.1 microns Hg to 1600 microns Hg). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint. The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 microns and from 1 to 50 microns of mercury. The Thermocouple gage permits measurements in the range from 1 to 1000 microns of mercury. The Discharge gage operates within the range of 0.001 to 20 microns of mercury.

2.7 oil

The Hyvac S14 is shipped with the oil drained from the reservoir. One quart of oil is supplied with each pump for the first filling and for periodic oil changes. To fill the pump with oil, first remove the exhaust dome (1) Fig. 4 and fill through the opening otherwise taken by the exhaust dome up to the oil level sight gage (22). After the pump has been operating several minutes, observe the oil level. If oil is visible at the oil sight gage, allow the pump to reach its operating temperature (about 1 hour) the intake being closed to atmosphere using plastic cap No. 24 (Fig. 4) supplied with pump. Observe the oil level again. If necessary, add oil to bring oil level slightly above the center of the gage.

2.8 belt guard

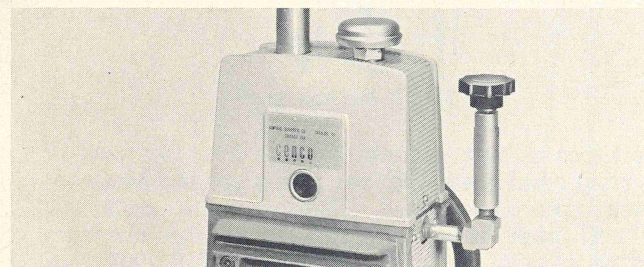
A well designed guard is a desirable protection against personnel hazards, and also protects the pump from damage caused by objects becoming entangled in the belt or pulley. Cenco pump bases are drilled to receive the guards, and each guard is sold ready for mounting. The order number for this belt guard is given in Paragraph 5.2.

3 operation

3.1 lubrication

When oil has become contaminated it should be changed. The oil may be removed by opening the drain No. 19 (Fig. 4) located at the front of the housing. Turn the shaft several revolutions to force out any remaining oil. Flush with cleaning flushing oil No. 93060 at least once and then refill with new Hyvac Oil No. 93050. The frequency of oil change is dependent upon the service of the pump. An oil change may be needed only once in six months or longer if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosion and easily condensable vapors enter the pump.

3.2 gas ballast



The gas ballast feature has been incorporated to prevent contamination of the pump oil when pumping condensable vapors. The gas ballast valve located at the rear of the housing allows regulation of the air flow (gas ballast) into the compression cycle of the stage. This ballast flow reduces the compression ratio of the present vapor volume in the stage, thus preventing condensation of the vapor and emulsifying with the oil.

If large amounts of water vapor are pumped and a large ballast flow is used, some oil mist will be discharged with the ballast air and vapor. Therefore, it is good practice to pipe the exhaust to the outside atmosphere. For best performance a simple condensate trap should be provided in the exhaust line as close to the pump as possible to prevent the condensate which will form in the pipe, from running back into the pump.

The gas ballast pump is ideally suited for pumping all vapors which do not chemically attack or dissolve in the pump oil, water being a typical example. Even if contamination of the oil has occurred, the gas ballast pump is able to purify the oil, if the system is temporarily shut off from the pump and the pump kept running for a suitable length of time. The contaminated oil will continually enter the pump through the oil supply channel. This oil circulates into the high vacuum side and the contaminant will evaporate. This vapor then will be exhausted out with the ballast air as described before until eventually all the contaminant has been expelled. For this reason the oil of a pump employing the gas ballast feature does not have to be changed nearly as often as described in the preceding paragraph.

The following is a calculation of maximum pumping rate without contamination of the pump oil for insoluble vapors where:

- T_p = pump temperature ($^{\circ}\text{K}$) (taken as pump oil temperature)
 T_a = ambient temperature ($^{\circ}\text{K}$)
 P_a = barometric pressure (mm Hg)
 P_s = saturation pressure of pumped vapor at pump temperature T_p (mm Hg)
 P_e = pressure under pump exhaust valve at instant of exhausting (mm Hg)
 V = rate of dry gas ballast flow at atmospheric pressure P_a (lit/min)
 D = density of pumped vapor at temperature T_p and pressure P_s (g/lit)
 W = maximum safe mass rate for pumping vapors (g/min)

then

$$W = D V \frac{P_a}{P_e - P_s} \frac{T_p}{T_a} \quad (\text{g/min})$$

For the special and frequent case of water vapor and assuming a pressure of 850 mm Hg below the exhaust valve at instant of exhausting and substituting the density of water vapor, we obtain:

$$W_{\text{water vapor}} = 0.289 \frac{V}{T_a} \frac{P_a P_s}{850 - P_s} \quad (\text{g/min})$$

Using 10 lit/min gas ballast flow, the following maximum vapor pumping rates for no condensation in the pump are obtained:

Pump Temperature $^{\circ}\text{C}$	50	60	70	80
Maximum water vapor pumping rate with zero humidity in ballast air (g/min)	0.91	1.60	2.84	5.38
With 100% humidity in ballast air (g/min)	0.72	1.39	2.59	5.08

For above data

$$P_a = 760 \text{ mm Hg}; T_a = 20^{\circ}\text{C} = 293^{\circ}\text{K}$$

If the ultimate vacuum of the pump is not required, it is possible to obtain almost noiseless operation by cracking open the gas ballast valve a very small amount. The ultimate pressure which can be obtained then is approximately 30 microns.

4 maintenance

4.1 general

The maintenance requirements of the Cenco Hyvac S14 Pump will vary with application. Proper lubrication is the most important factor in securing reliable performance. (See paragraph 2.7).

4.2 shaft seal replacement

The seal on the pump shaft, No. 32 (Fig. 4) consists of a "Truarc" ring, No. 33, and a shaft seal No. 30. Remove the "Truarc" ring, and the shaft seal.

Before assembling or making a replacement, apply a film of the pump oil to the pump shaft. Also apply a film of the same oil to the inner surface of the

shaft seal. Replace the shaft seal, exercising care that the inner surface of the rubber seal ring is not damaged. Push the seal back so that it contacts the seal endplate. Force the washer and spring over the groove in the shaft and replace the "Truarc" ring.

4.3 repairs

Fig 4 shows cross sectional view of the Hyvac S14 pump. Paragraph 5.1 lists all the parts for the pump. When ordering replacement parts, please state the exact part number. For repairs to the pump other than the replacement of the shaft seal and where adequate shop facilities are not available, it is strongly recommended that the pump be returned to the factory.

5 replacement parts and accessories

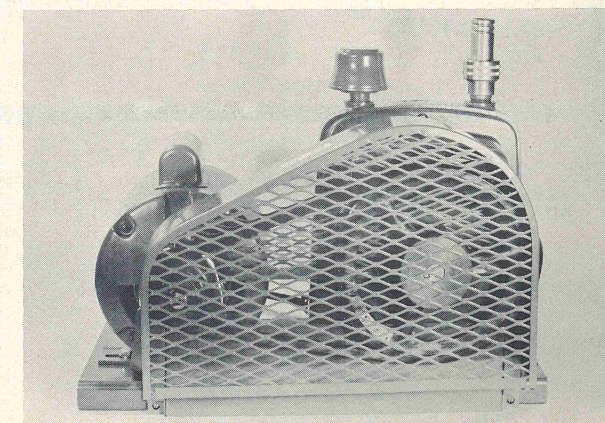
5.1 replacement parts

The numbers in the left hand column are identical with the numbers in Fig. 4.

Item	Part Description	Parts per Pump	Part No.
1	Exhaust Dome	1	90600Z-8
2	Baffle	1	P 60967
3	Flutter Valve	1	P 65587
4	Top Wrapper	1	P 65596
5	Knob	1	P 26100
6	Valve Assembly	1	P 67416
7	Valve Pin	1	P 60968
8	Pipe Elbow	1	90600Z-2
9	Pipe Nipple	1	90600Z-3
10	Soc. Hd. Set Screw, Full Dog. Pt.	1	1/4 - 20x3/8
11	Exhaust Port Insert	1	P 60970
12	Stator	1	P 60959
13	Spring Pin	2	P 63503
14	Compression Spring	2	P 28082
15	Bind. Hd. Stl. Mach. Screw	4	4 - 40x1/4
16	Wrapper	2	P 65595
17	Rotor	1	P 60963
18	Vane	2	P 60964
19	Drain Plug	1	90600Z-5
20	Drain	1	90600Z-4
21	Rd. Hd. Stl. Mach. Screw	2	10 - 24x1/4
22	Oil Level Window	1	P 35291
23	O - Ring	1	P 27140
24	Plastic Cap	1	P 26077
25	Deflector	1	P 60984
26	Baffle	1	P 65594
27	Intake Nipple	1	P 60966
28	Soc. Hd. Stl. Cap Screw	4	10 - 32x1/2
29	Thrust Washer	1	P 78034
30	Shaft Seal	1	P 35459
31	Shaft Key	1	P 29313
32	Shaft	1	P 60965
33	Truarc Ring	2	P 29260

34	Soc. Hd. Stl. Cap. Screw	8	1/4 - 20x7/8
35	Seal End Plate	1	P 60960
36	O - Ring	2	P 27141
37	Rd. Hd. Drive Screw	4	No. 00x1/8
38	Direction Plate	1	P 25275
39	Shaft Key	1	P 29313
40	Rear End Plate	1	P 60961
41	Cover Gasket	1	P 35483
42	Rd. Hd. Drive Screw	2	No. 00x1/8
43	Name Plate	1	90600Z-6
44	Cover	1	P 60989

5.2 accessories



BELT GUARD for enclosing the pump and motor pulleys and belts where moving parts constitute a personnel hazard. Comes ready to screw to tapped pump base.

No. 91508 Belt Guard\$15.50

VACU RULE, a handy slide rule for calculating low pressure conductance, system evacuation times, and typical vacuum conversion factors.

No. 94008 Vacu Rule\$1.00

McLEOD GAGE, dual range, for calibrating electronic gages, making absolute pressure readings, and other vacuum applications where extreme accuracy is necessary. One range reads directly from 0.5 to about 200 microns, the other to about 1.6 mm. Requires 10 lbs. of mercury.
No. 94151 McLeod Gage\$205.00

VACUUM PUMP OIL especially processed to maintain its low vapor pressure up to 50°C and low viscosity down below 15°C. Must be used to achieve the guaranteed performance of our oil sealed pumps. Also comes in 1 and 5 gallon containers.
No. 93050-2 Light Pump Oil, per quart.....\$.75

FLASK, VACUUM DEWAR TYPE, for use with liquid air traps. Metal base with silvered glass body; 1000 ml capacity, 30 cm inside length, 70 mm inside diameter, made of "Pyrex" brand glass.
No. 15830-3 Vacuum Flask\$12.25

LIQUID AIR TRAP, "Pyrex" brand glass, for either absorbing or "freezing out" vapors and gases before reaching the pump. Most applications require only a mixture of 80% dry ice and 20% alcohol in a Cenco No. 15830-3 Vacuum Flask. Dimensions of trap: 37 cm long, 28 mm OD, 19 mm diameter connecting tubes.
No. 94005 Liquid Air Trap\$6.50

LIQUID AIR TRAP, same as above but equipped with standard taper joint for emptying the condensate.
No. 94006-1, 25 diameter, 12 mm tubes.....\$19.25
No. 94006-3, 30 diameter, 19 mm tubes.....\$21.00
No. 94006-4, 40 diameter, 25 mm tubes.....\$25.00

ADAPTOR, 3 PRONG TO 2 PRONG, for fitting three wire, safety male plugs to common two prong 115 volt sockets. Grounding wire and lug allow pump line to be grounded to convenient screw on junction box.
No. 84097 Adaptor\$.38

6 bibliography

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Vacuum Systems, Seals and Valves, Franz N. D. Durie, Rev. Sci. Inst. 19, 485 (1948)

High Vacuum Technique, J. Yarwood, (John Wiley and Sons, Inc.) 1955

High Vacua, Swami Jnanananda, (D. Van Nostrand Company, Inc.) 1947

Scientific Foundations of Vacuum Technique, Saul Dushman, (John Wiley and Sons, Inc.) 1949

Vacuum Technique, Arnold L. Reimann, (Chapman Hall Ltd., London) 1952

Industrial High Vacuum, J. R. Davy (Sir Isaac Pitman & Sons, Ltd.) 1951

7 price list

CENCO NO.	MOTOR RATING	PRICE
90605-1	115/230 V. 60 Cycle	\$225.00
90605-7	115/230 V. 50 Cycle	240.00
90605-10	115/230 V. 60 Cycle (explosion proof)	265.00
90605-18	220/440 V. 50/60 Cycle 3-phase	235.00
90605-23	Pump mounted on plate without motor	200.00
90600	Unmounted pump only	190.00

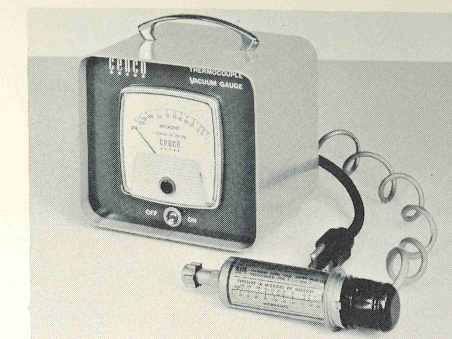
CENCO HYVAC S14 SINGLE STAGE PUMP

high vacuum gages

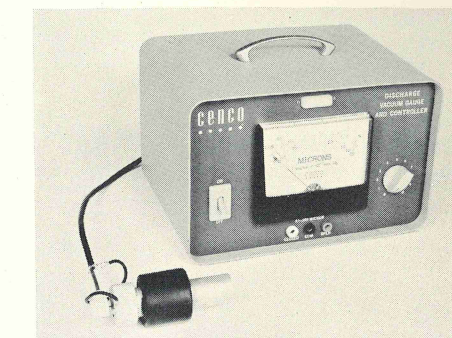
THERMOCOUPLE VACUUM GAGE for measuring pressures in the range of 1 to 1000 microns of mercury, read directly on a single meter scale. Gage head is shock resistant and cannot be damaged by exposure to atmospheric pressure. Voltage regulation circuit makes this light weight unit insensitive to operating line voltage changes (115 volts, 60 cycles A.C.).
No. 94178 Thermocouple Gage\$110.00

DISCHARGE VACUUM GAGE AND CONTROLLER for direct reading of pressures between .001 and 20 microns of mercury on a single scale. Gage head is shock resistant and unaffected by atmospheric pressure. Transistor amplifier circuit activates relay at any pre-set pressures to either start or stop auxiliary equipment. Operates on 115 volts, 60 cycle A.C. and will control external equipment drawing up to 1 ampere without having to use relays (Cenco Nos. 99720-1 or 99725).
No. 94183 Discharge Gage\$249.50

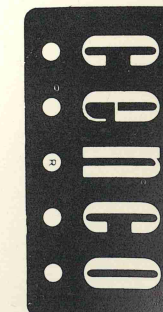
PIRANI GAGE, improved design based on hot-wire principles, for direct readings from 1 to 2000 microns of mercury in two scales. Measures total pressure of condensable vapors and gases in the complete system. Output for 10 millivolt recorder. Operates on 15 watts, 115 volts, 60 cycle A.C.
No. 94185 Pirani Gage\$196.00



THERMOCOUPLE



DISCHARGE

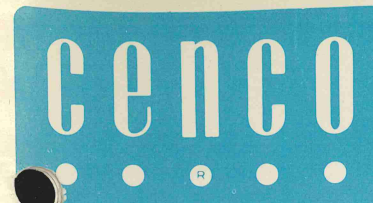


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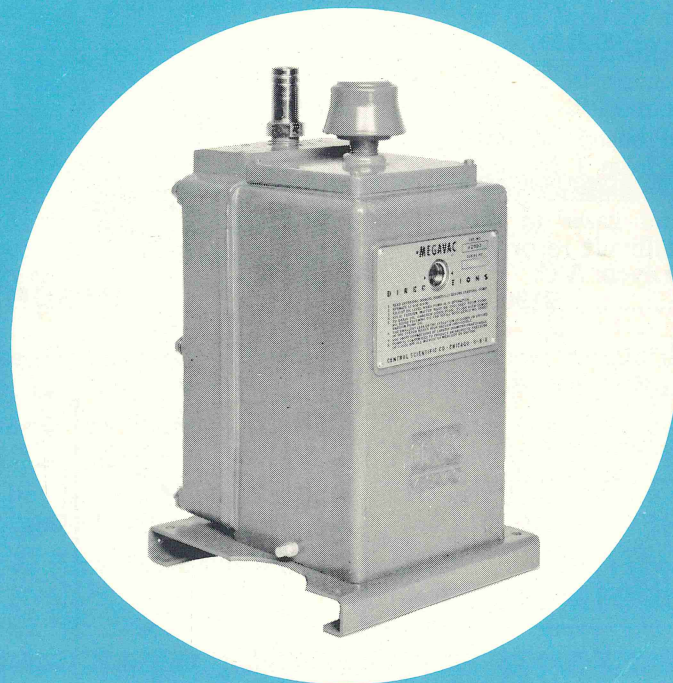


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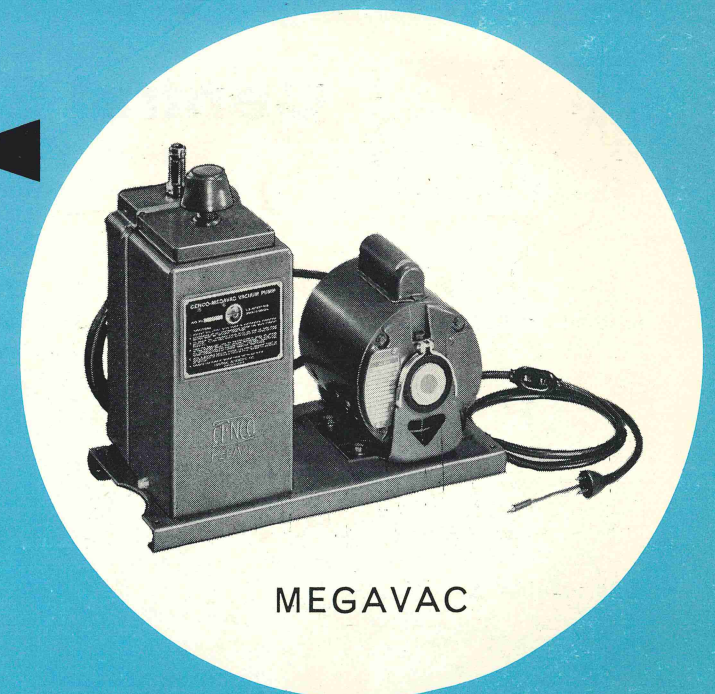
CENCO MEGAVAC PUMP



A two stage, oil sealed mechanical pump of the external vane eccentric rotor design for use in general laboratory requirements such as backing diffusion pumps. Rated at 57 liters per minute pumping capacity at atmospheric pressure, the megavac will pump down to a guaranteed pressure of 0.1 microns of mercury. Comes unmounted or with a choice of electric motors mounted on a heavy base plate with a pulley, belt, line cord and 3 prong plug. Model No. 92003-1 comes with the 115/230 volt, 60 cycle motor at a price of

\$258.50

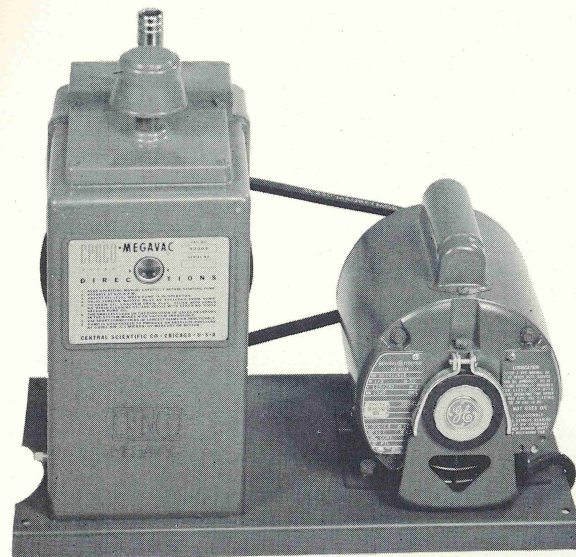
	GUARANTEED VACUUM (microns of mercury)	CAPACITY		BOOKLET
		at atmosphere (liters per min.)	at 1 micron (liters per min.)	
Hyvac	0.3	10	5	320
Hyvac 2	0.1	21	9	321
Hyvac 7	0.1	70	30	
Hyvac 14	0.1	140	60	
Hyvac S14	10.0	140	—	322
Megavac	0.1	57	22	323
Hypervac 23	5.0	240	—	324
Hypervac 25	0.1	264	120	
Hypervac 100	0.1	960	660	
Pressovac	15.0	35	—	325
Blower Pump	3 IN. Hg	35	—	326



MEGAVAC

CENCO MEGAVAC PUMP

Booklet 323 operation and maintenance instructions



A two stage, oil sealed mechanical pump of the external vane eccentric rotor design for use in general laboratory requirements such as backing diffusion pumps. Rated at 57 liters per minute pumping capacity at atmospheric pressure, the megavac will pump down to a guaranteed pressure of 0.1 microns of mercury. Comes unmounted or with a choice of electric motors mounted on a heavy base plate with a pulley, belt, line cord and 3 prong plug. Model No. 92003-1 comes with the 115/230 volt, 60 cycle motor at a price of

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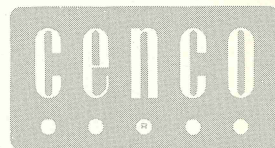
All prices F.O.B. our nearest branch as of publication date. Applicable taxes will be added. Exact current prices available on request. Terms: 30 days net.

We have attempted to describe accurately the merchandise listed in this bulletin. Additional information will be gladly given upon request. The company warrants that each item of merchandise sold by it is free from defective workmanship or material upon return of the same to the company office at Chicago, Illinois. This warranty is made in lieu of all other warranties, express or implied, and no other warranty, express or implied, is assumed or will be assumed.



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SALES REPRESENTATIVES THROUGHOUT THE WORLD

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1 description

1.1 general

The Cenco Megavac pump is a rotary, oil-sealed pump operating on the principle of the eccentric rotor with spring-actuated moving vane. Air at atmospheric pressure is forced into a smaller volume by the action of an eccentric rotor with moving vane always in contact, and is expelled from the exhaust port. (See Figures 4 and 5).

The Megavac is a two-stage, series connected pump. The two stages, intake and exhaust, have equal volumetric displacement. In the present model of the Megavac the design utilizes a single spring to actuate both vanes.

By immersing the entire mechanism in a bath of oil, the oil serves the three fold purpose of (1) insuring a vacuum tight seal of the stages, (2) serving as a coolant, and (3) lubricating the moving parts.

1.2 pump data

The speed pressure characteristics of the Cenco Megavac Pump are shown in Fig. 1. Additional pump data are as follows:

Pump speed (rpm)	600
Capacity at atmospheric pressure (liter/min.)	57
Capacity at 1 micron of mercury (liter/min.)	22
Guaranteed vacuum (microns of mercury)	0.1
Merit Factor (%) ¹	37

¹ The merit factor is the ratio of the pumping speed at one micron to the pumping speed at atmospheric pressure.

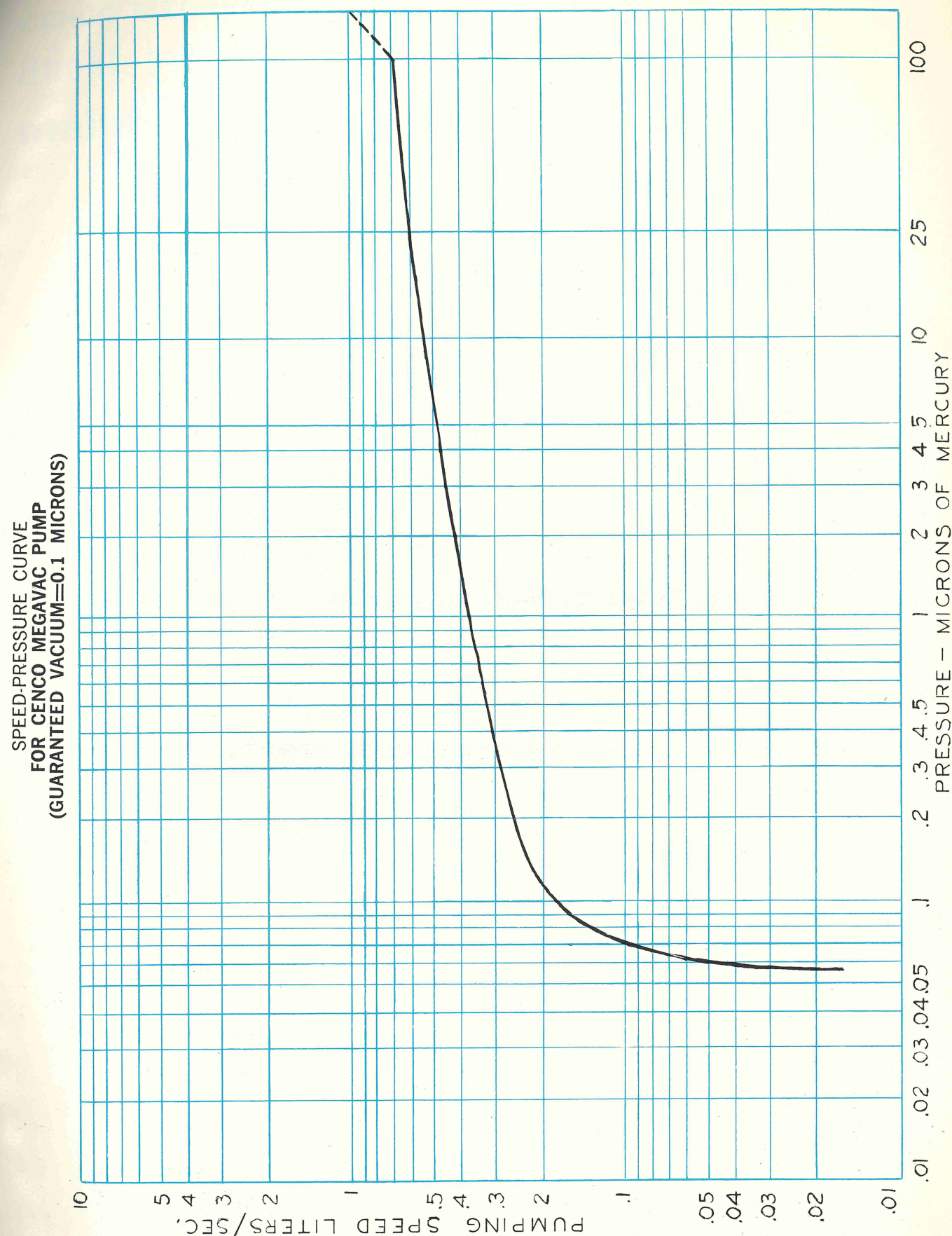
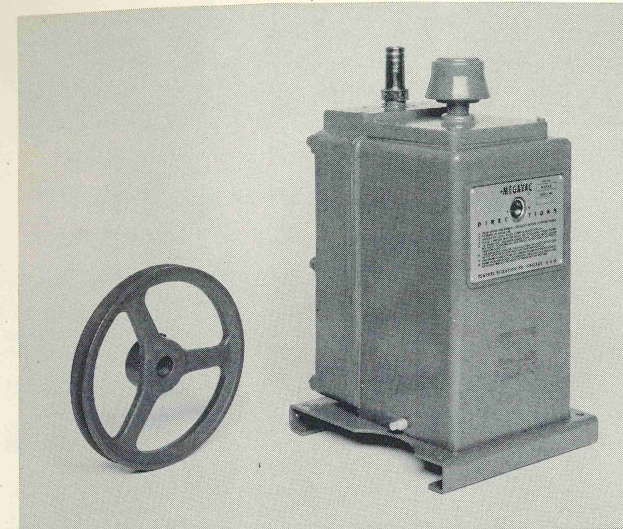


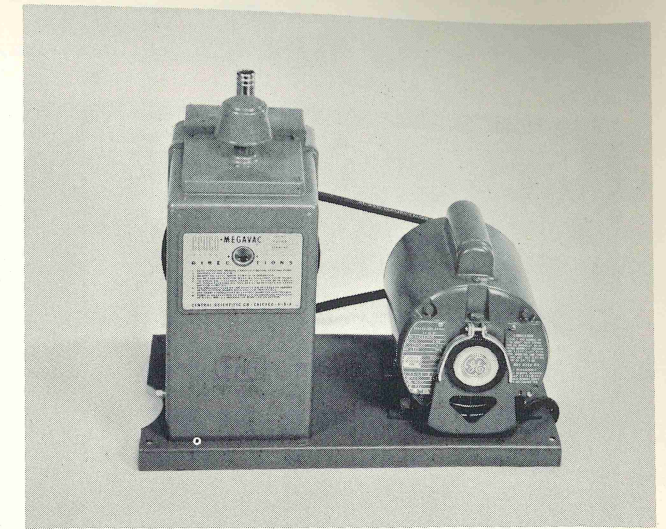
Fig. 1

1.3 unmounted pump



The Megavac Pump, Cenco No. 92001, is supplied with a grooved pulley and is mounted on a subbase for floor or table mounting.

1.4 pump, mounted with motor



The Megavac Pump, Cenco No. 92003, is assembled on a steel base and supplied with motor and a belt drive.

CENCO MEGAVAC PUMP

Cenco Cat. No.	Motor Rating
92003-1	115/230 V., 60 cycle, 1 phase, 0.33 hp.
92003-7	115/230 V., 50 cycle, 1 phase, 0.33 hp.
92003-10	115/230 V., 60 cycle, 1 phase, 0.33 hp. explosion proof

Cenco Cat. No.	Motor Rating
92003-18	220/440 V., 50/60 cycle, 3 phase, 0.33 hp.
92003-23	No motor

2 installation

2.1 mounting

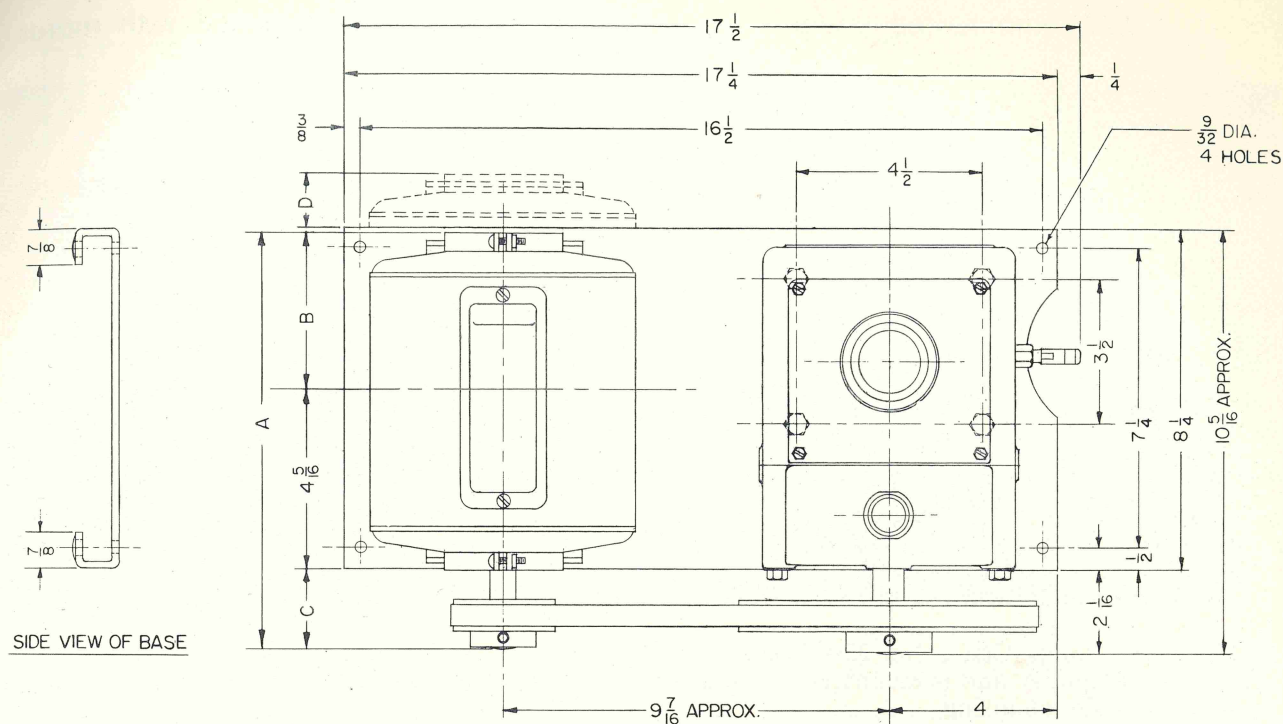
If the mounted pump is obtained, the pump is immediately ready for use.

If an unmounted pump is obtained, provisions should be made for bolting the subbase to the floor or, if used in a movable unit, to the frame. When electronic equipment is attached to the same frame Shock mounts should be obtained so that vibrations from the motor or pump will not be transmitted through the frame.

A belt drive connects the motor with the pump. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump. The pump may be driven at any speed from about 325 RPM to 600 RPM. Variations in speed in this range will normally affect only the volumetric speed of the pump. The major dimensions of the pump, pump base and motor are given in Fig. 2.

2.2 motor connection

Motors have a connecting 3 conductor grounded cord and plug attached (except Cenco Nos. 92003-10 and 92003-18). In all cases, connect the motor to a powerline of the voltage frequency and phase as indicated on the nameplate of the motor. The powerline should be heavy enough to carry the current required without an undue drop in voltage. Two main types of motors are used: (a) single phase, capacitor start type alternating current motors; (b) squirrel cage induction three-phase motor. Fuses provide short circuit protection only for the power supply line and do not protect the motor from overload. It is recommended that a suitable motor starting switch with motor overload protection be used for all permanent installations. On motors supplied with connecting cord and plug, connection has been made for operation on 115 V. For operation on 230 V re-connect as shown on inside of the cover of the motor connection box.



SIDE VIEW OF BASE

CATALOG NO.	DIMENSIONS			
	A	B	C	D
92003 - 1	10 1/8	3 7/8	1 15/16	
92003 - 7	11	4 3/4	1 15/16	
92003 - 10	13 5/8	7 9/16	1 7/8	3 5/8
92003 - 18	10 1/8	3 7/8	1 15/16	

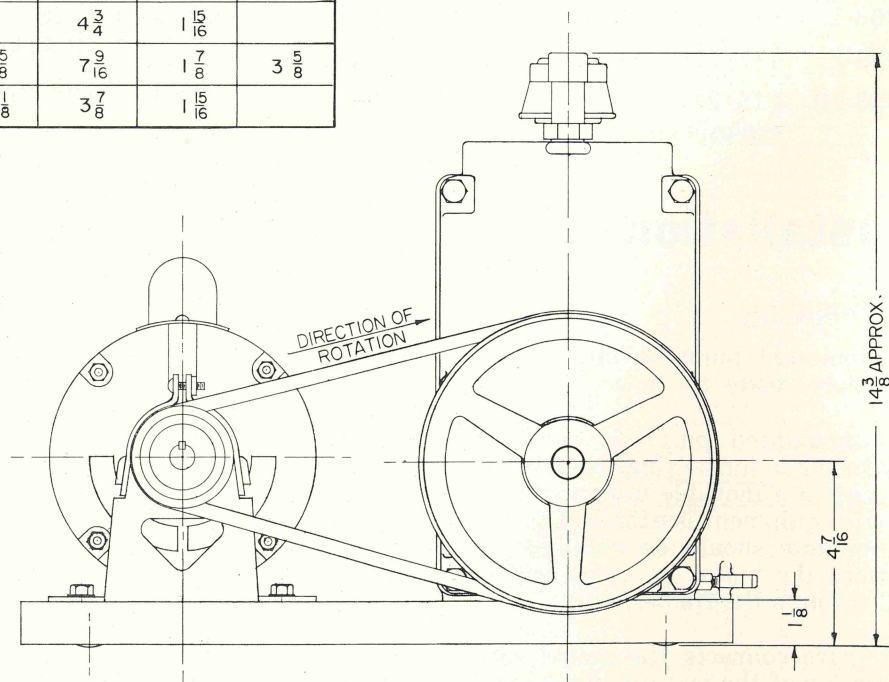
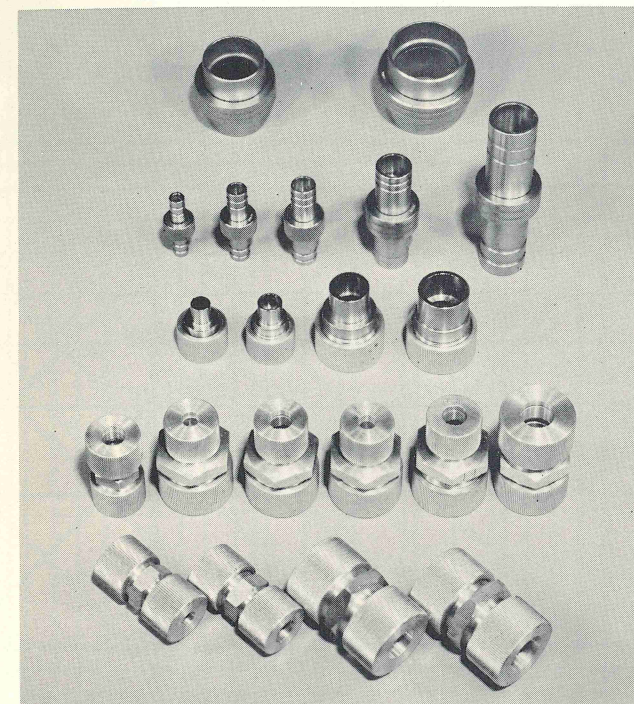


Fig. 2, outline of Megavac, 92003

For correct selection of the fuse, consult the list below:

Cenco Pump No.	Current at full load (amperes)	Max. fuse rating (amperes)
	115/230 V	115/230 V
92003-1	5.6/2.8	20/15
92003-7	6.2/3.1	25/15
92003-10	5.6/2.8	20/15
92003-18	1.6/0.8	15/15

2.3 vacuum connections



Typical Cenco Vacuum Connectors

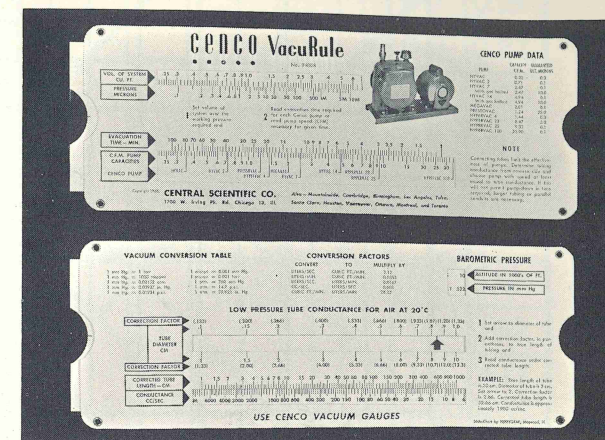
During shipment the intake nipple of the Mega-vac Pump is closed to prevent entrance of foreign matter into the pump. In handling the pump, similar precautions should be exercised.

When connecting the pump to the system to be evacuated, extreme care must be taken to eliminate leakage. All connections should be as short as possible, and of large diameter to reduce molecular friction. When the pump is operating in the low micron range, the flow of gas through a tube is substantially molecular in character. At low pressures, the gas removed from the system is confined largely to those molecules which, because of their kinetic energy of agitation, happen to hit the intake of the pump when the cylinder of the pump is open to the intake. The conductance of various size tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008, or may be determined

from Fig. 3, in which $(L + \frac{4}{3}D)$ is plotted against Z, the conductance in cubic centimeters per second. L and D are the length and inside diameter of the tubes in centimeters.

The net speed of the system then may be found by the following relationship:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$



No. 94008 Cenco VacuRule

where S_1 is the pump speed taken from Fig. 1 and Z is the conductance of the tubing. The time required to evacuate a vessel of volume V is given by the formula:

$$T = \frac{2.3 V}{S} \cdot K$$

where T is the time in seconds, V the volume expressed in liters, and S the average speed of the pump expressed in liters per second over the range from atmospheric to the desired final pressure. The factor K has values of 4, 5 or 6. The factor 4 is used if the final pressure is 100 microns, 5 for 10 microns, and 6 for 1 micron.

If metal piping is used, it is best to solder or braze all connections. When threaded pipe joints must be used, the threads should be as perfect as possible. In such a connection, screw the members together several turns, and then apply Glyptal to the exposed threads before screwing together tightly. Allow the Glyptal to dry several hours before starting the pump. If flanged connections are used, flat or O-ring gaskets made of rubber or Neoprene should be used between the flanges to eliminate leakage. Place a thin coat of oil on the "O" ring before using.

Cenco manufactures an extensive line of couplings, connectors and accessories for use in high vacuum systems (see Cenco Booklet 327). Some of these are:

Cenco No.	Name	For Tubing	Size Range
94226	straight through	glass and/or metal	3/8" - 1"
94235	straight through	metal and/or rubber	1/4" - 2"
94228	reducing	glass and/or metal	3/8" - 1"
94230	connectors	metal-to-glass	3/8" - 1"
94240	caps	for 94235	1/4" - 2"
94245	nipples	rubber	3/8" - 1 3/16"

CONDUCTANCE OF TUBES FOR AIR AT 20°C

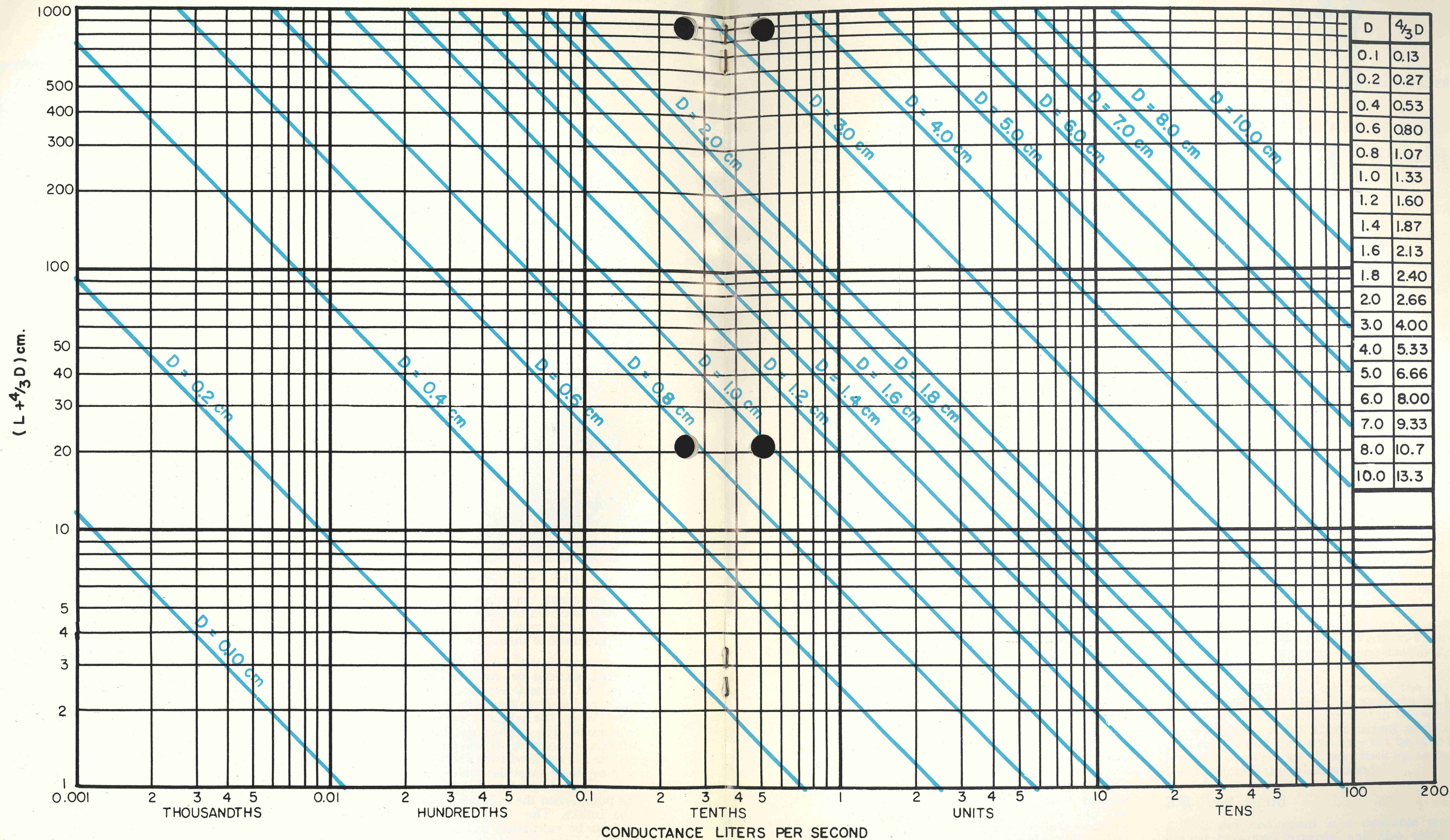


Fig. 3

TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain pumping speed (S) as large as possible, the tube conductance (Z) must be very large as compared with the speed of the pump (S_1), as is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$
$$S = \frac{Z}{S_1 + Z} \cdot S_1$$

Since at best (S) is only a fraction of (S_1), the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance, (Z), shown in litres/sec, is plotted as abscissas against the quantity ($L + \frac{4}{3}D$), in cm., as ordinates. In addition to the parameter D, the value of $\frac{4}{3}D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the value of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm. long having a diameter of 2 cm. is required. From the table, for D=2, it is seen the $\frac{4}{3}D = 2.66$ cm. Referring to the curve, for D=2 the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines, spaced logarithmically, conductance of tubes having other diameters than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely

$$\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$$

where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

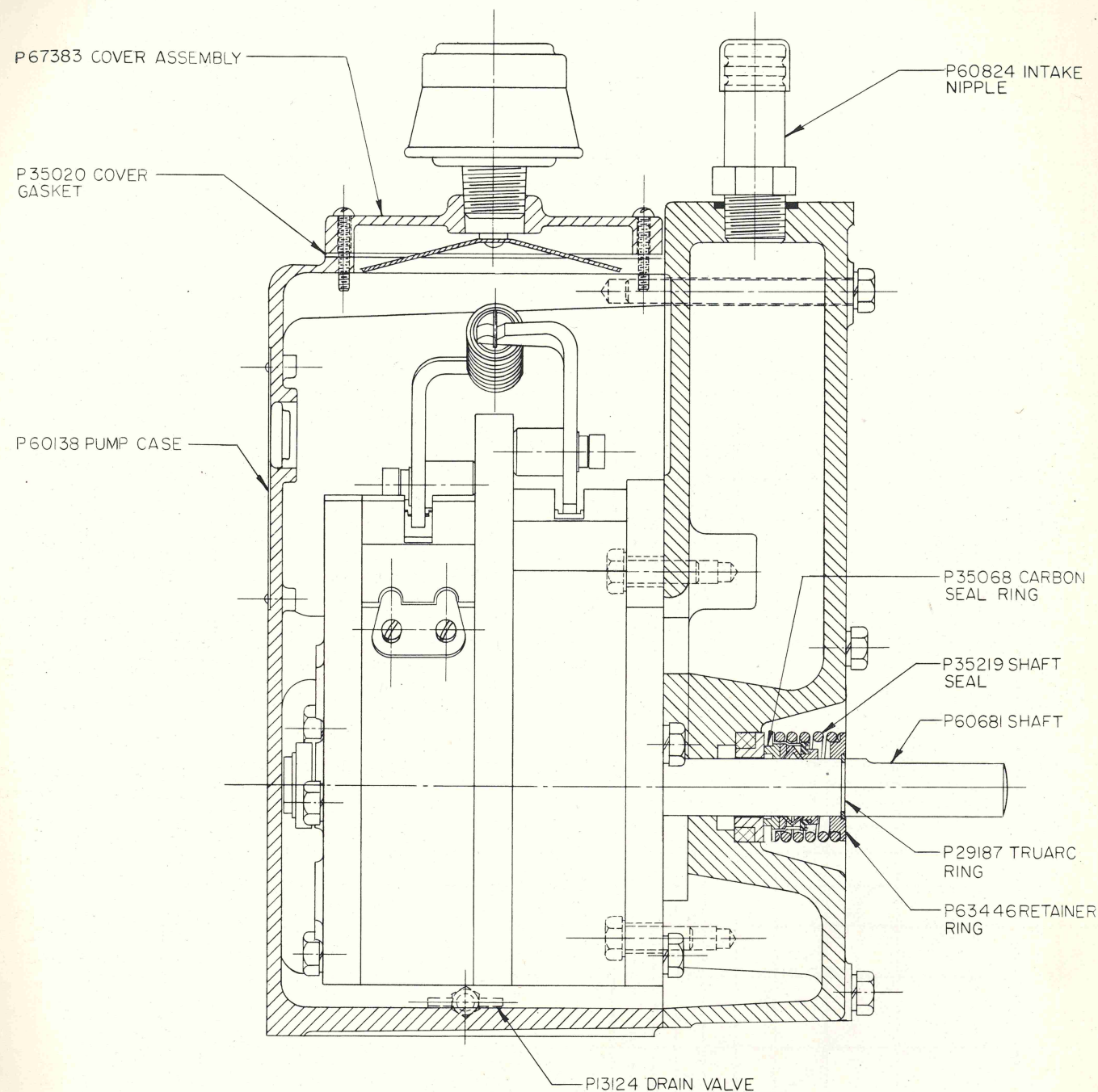


Fig. 4, sectional view of Megavac

The Megavac pump is provided with a one-piece intake nipple. As supplied, the nipple is intended primarily for use with rubber tubing. When glass connections are used between the pump intake nipple and the system, it is recommended to use a short rubber hose as a coupling between nipple and glass tube.

When tapered glass joints or ball joints are used in connections, a vacuum stopcock grease (No. 15517-1 or No. 15522) should be applied to both members.

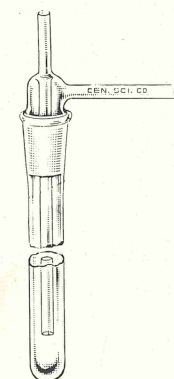
Rubber tubing connections should be kept as short as possible and made with an extra heavy wall, gum tubing, such as No. 18204, which has been compounded specially for vacuum work. All connections to metal or glass tubing should fit snugly and both members should be coated with vacuum stopcock grease.

2.4 valves

Metal vacuum valves and glass stopcocks are employed generally in the connecting line between the pump and the system to provide a means of connecting the vacuum gage and for vacuum release when stopping the pumping. When metal pipes are used for the line, a high-vacuum valve such as No. 94551 is recommended.

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of testing the pump, and system for leaks by the "pressure rise" method without disconnecting the pump from the line.

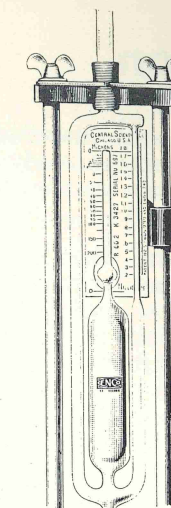
2.5 traps



No. 94005 liquid air trap No. 15830-3 Dewar flask

Extreme care must be taken to prevent solid particles from reaching the intake of the pump. They will score the working parts of the pump and reduce its efficiency. If corrosive vapors are in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor from the pump from entering the system. A Cenco No. 94005 or No. 94006 Glass Trap is recommended. Either should be used in a No. 15830-3 Vacuum Flask. The refrigerant most commonly used in the vacuum flask is a mixture of solid carbon dioxide (dry ice) and acetone or ethyl alcohol.

2.6 gages



No. 94151 McLeod gage

The types of high vacuum gages commonly used in a system employing a Megavac pump are the McLeod, Pirani, Discharge, and Thermocouple gage.

A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 mm Hg to 1.6 mm Hg (0.5 microns Hg to 1600 microns Hg). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint. The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 microns and from 1 to 50 microns of mercury. The Thermocouple gage permits measurements in the range from 1 to 1000 microns of mercury. The Discharge gage operates within the range of 0.001 to 20 microns of mercury.

2.7 oil and drain valve

The oil drain valve is removed during shipment in order to prevent damage. Before adding oil to the pump, remove the pipe plug and replace by means of the drain valve. Best seals will be obtained by applying Glyptal to the drain valve thread before screwing into the pump housing.

The oil is drained from the pump for shipment. A gallon of Cenco No. 93050 Vacuum Pump Oil is supplied with each pump. Approximately 3 quarts are needed in the pump.

To fill the pump with oil, remove the top cover and fill with the oil supplied until the oil level is slightly above the level indicated in the window on one side of the pump. If insufficient oil is used, a good seal around the vanes may not be maintained. If too much oil is used oil may back up through the pump trap into the vacuum line.

2.8 belt guard

A well designed guard is a desirable protection against personnel hazards, and also protects the pump from damage caused by objects becoming entangled in the belt or pulley. Cenco pump bases are drilled to receive the guards, and each guard is sold ready for mounting. The order number for this belt guard is given in Paragraph 5.2.

3 operation

If the pump has been installed as described in paragraph 2, the pump is ready for operation. In continued service only proper lubrication has to be maintained.

When oil has become contaminated it should be changed. The oil may be removed by opening the drain located at the side of the housing. Turn the shaft several revolutions to force out any remaining oil. Flush with clean flushing oil No. 93060 at least once and then refill with new Megavac Oil No. 93050. The frequency of oil change is dependent

upon the service of the pump. An oil change may be needed only once in six months or longer if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosion and easily condensable vapors enter the pump.

Due to the operation of the ball valve in the exhaust stage, Megavac Pumps normally operate with a clicking sound which becomes sharper as the pump warms up and the pressure is reduced. When the pump is used continuously the oil temperature may reach 50° to 60°C.

4 maintenance

4.1 general

The maintenance requirements of the Cenco Megavac Pump will vary with application. Proper lubrication is the most important factor in securing reliable performance. (See paragraph 2.7).

If a pump is connected into a normal leak-free system, there should be no condition which should cause the pump to malfunction that cannot be remedied by simple adjustments. If a pump does not function properly, the cause usually can be attributed to a broken spring, a sticking vane or worn valve release and not a misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal use, therefore, where no corrosive vapors are encountered, it is reasonable to expect that there will be no decrease in the efficiency of a pump over a period of several years.

4.2 shaft seal replacement

The seal on the pump shaft, P60681, consists of a "Truarc" ring, P29187, and a shaft seal P35219. Remove the "Truarc" ring, and the shaft seal.

Before assembling or marking a replacement, apply a film of the pump oil to the pump shaft. Also apply a film of the same oil to the inner surface of the shaft seal. Replace the shaft seal, exercising care that the inner surface of the rubber seal ring is not damaged. Push the seal back so that it contacts the seal end plate. Force the washer and spring over the groove in the shaft and replace the "Truarc" ring.

4.3 exhaust valve

It is quite possible, after many hours of pump operation, for the exhaust valve retainer to wear from constant hammering of the ball valve. This will cause the pump to lose efficiency, spray oil and make a pounding noise because the ball valve has either dropped out entirely or is traveling too great a distance. The pump will not reach its guaranteed vacuum due to the fact that oil is continually entering the exhaust opening. The valve retainer and the ball valves can be replaced very easily after removing the pump mechanism from its case.

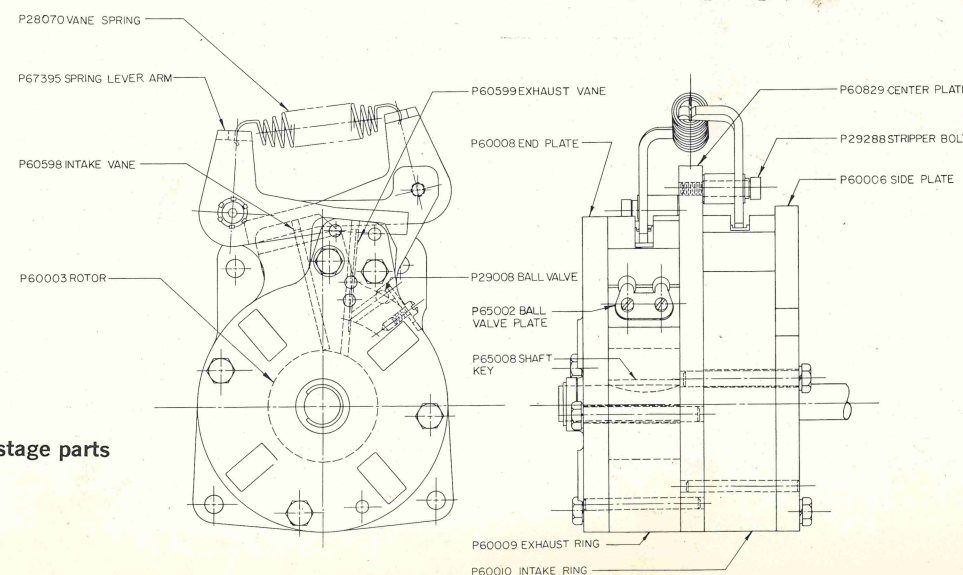


Fig. 5, intake & exhaust stage parts

4.4 vanes

Vanes and spring in the Meavac Pump can be inspected by removing the top plate. A broken spring will prevent the vanes from riding snugly against the rotor during its cycle of operation thus causing a failure in operating efficiency. Vanes may be inspected occasionally but the process must be accomplished with extreme care. The vanes should be removed one at a time and not under any circumstances be interchanged or reversed in position. The vanes may be removed after the spring has been released. By turning the pump by hand, one can determine how much of the vane is protruding above the surface of the pump housing and any markings on this part of the vane will do no harm. It is our practice to pull the vanes out with sharp nosed pliers, but extreme care should be taken to see that the nose of the pliers does not extend down over the part of the surface which slips into the vane slot housing. The vanes might be rather difficult to remove because they are usually under atmospheric pressure. This is true particularly if the pump has been in operation just prior to the removal of the vanes. There are no loose parts which will become disturbed by the removal of the vanes and these can be taken out without any trouble. Any dirt or particles of grit which may be lodged around the upper part of the vanes should be carefully removed before the vanes are taken out since this material getting into the pump will score the stator as well as the rotor. After the vanes are removed, they may be polished slightly with the very finest of emery paper if they appear to be corroded. The vanes are ground to an established tolerance of 0.0005 of an inch and, therefore, no portion of the metal should be removed during the polishing process. As long as the pump is producing a satisfactory vacuum and no corrosion is present, it is advisable not to polish the vanes.

4.5 repairs

Simple repairs (replacing spring, etc.) may be done by the user. If shop facilities or an experienced mechanic are available more extensive repairs may be possible. However, for major repairs or complete overhaul, the pump should be returned to the factory. Request shipping instructions before returning.

Some parts are sold only to customers maintaining adequate shop facilities and experienced mechanics. Cleaning and reinstalling old parts, unless badly worn, is recommended as safer practice than attempting to refit new parts without the necessary tools and experience. Exhaust and intake vanes are supplied with one side only machined and ground and must be finished to fit the vane slot by the customer if it is impracticable to return the pump to us for repair.

Because of the great difficulty in refitting new rings P61048 and P61049 and in order to obtain absolute concentricity of the rotor with respect to the rings, these parts are sold only to pump users who are thoroughly experienced in pump assembly. Long experience in repairing pumps has proved that rings are seldom worn or damaged to the extent that replacement is necessary. We suggest that the old rings, if not scored or otherwise damaged, be cleaned and reinstalled with new rotors and vanes, if these latter parts are badly worn.

If pump parts are worn to the extent that new rings are necessary, the pump should be returned to our shop for overhauling and reconditioning. It is quite possible for an experienced mechanic to install new rings, but the task requires a special tool in order to locate dowel positions for drilling and to establish proper concentricity of the rotor with respect to the ring bore.

5 replacement parts and accessories

5.1 replacement parts

Part No.	Description	No. Req'd per Pump	Price Each
P60003	2 Rotors	2	\$12.00
P67395	Spring Lever Arms	2	3.00
P60006	2 Side Plate	1	12.00
P60829	2 Center Plate	1	11.50
P60008	2 End Plate	1	9.00
P60138	Finished Pump Case	1	18.40
P60598	2 Vane (Intake)	1	2.50
P60599	2 Vane (Exhaust)	1	3.00
P61048	3 Ring (Exhaust)	1	14.50
P61049	3 Ring (Intake)	1	13.50
P28070	Vane Spring	1	.35
P35020	Cover, Gasket	1	.10
P65002	Valve, Retainer Plate	1	.09
P29008	Valve Balls	2	.10
P67383	Cover	1	5.00
P65008	Shaft Keys	2	.80
P35219	Shaft Seal Assembly	1	5.95
P35068	Carbon Seal Ring (Only of above)	1	1.40
P63446	Retainer Ring	1	.85
P29187	Truarc Ring	2	.10
92006	Belt	1	2.00

5.2 accessories

Description	Cenco No.
Vacuum Pump Oil, Light Grade	93050
Vacuum Pump Flushing Oil	93060
Vacuum Sealing Tape	94222
Gylptal, Black	10021
Vacuum Couplings (metal to metal)	94235
Vacuum Couplings (metal to glass)	94230
Vacuum Couplings (glass to glass)	94226
Vacuum Reducer Couplings	94228
High-Vacuum Valve	94551
Vacuum Stop Cock Lubricant	15517
Vacuum Stop Cock Lubricant	15522
Rubber Tubing, Extra Heavy Wall	18204

² Only sold to customers with adequate shop facilities and experienced personnel.

³ Only sold to customers thoroughly experienced in pump assembly.

No. 94151 McLeod Gage.....	\$205.00
----------------------------	----------

No. 93050-2 Light Pump Oil, per quart.....\$.75

No. 15830-3 Vacuum Flask\$12.25

No. 84097 Adapter\$.38

No. 91708 Belt Guard.....\$15.00

No. 94008 Vacu Rule.....\$1.00

No. 94005 Liquid Air Trap\$6.50

densate.

No. 94006-3, 30 diameter, 20 mm tubes.....	\$23.50
--	---------

No. 94006-4, 40 diameter, 28 mm tubes.....\$25.50

High Vacuum Apparatus, Bulletin 10, Central Scientific Company

Sullivan, Rev. Sci. Inst. 19, 1 (1948)

Kurie, Rev. Sci. Inst. 19, 485 (1948)

High Vacuum Technique, S. Fairwood, (John Wiley and Sons, Inc.) 1955

High Speed, Swann Shanahan, (E. Van Nostrand Company, Inc.) 1947

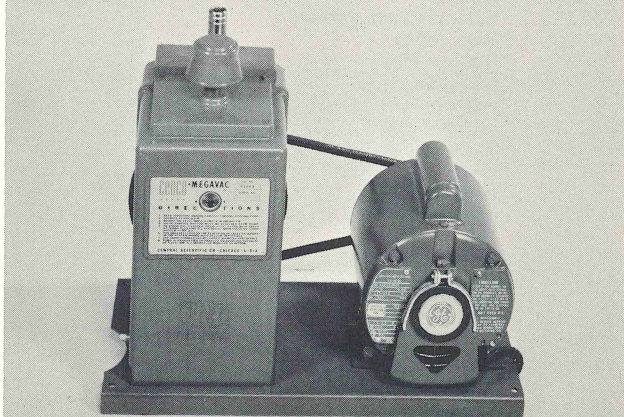
Dushman, (John Wiley and Sons, Inc.) 1949

Vacuum Technique, Arnold E. Reimann (Chapman Hall Ltd., London) 1952.

Industrial High Vacuum, S. R. Davy (Sir Isaac Pitman & Sons, Ltd.) 1951

CENCO NO.	MOTOR RATING	PRICE
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92003-7	115/230 V. 50 Cycle	265.25
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high vacuum gages

THERMOCOUPLE VACUUM GAGE for measur-

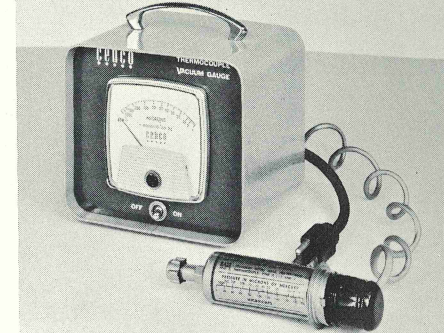
No. 94178 Thermocouple Gage\$110.00

CONTROLLER for direct reading of pressures between

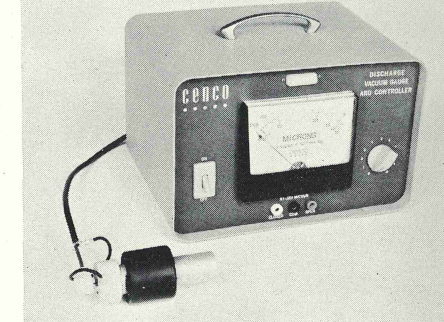
No. 94183 Discharge Gage\$249.50

wire principles, for direct readings from 1 to 2000

Op. 94185 Pirani Gage\$196.00



THERMOCOUPLE



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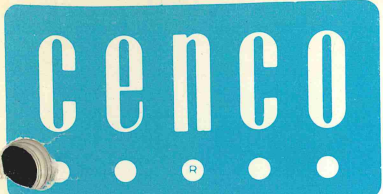
State

ATTN:

Booklet 323

QTY.	CAT. NO.	ARTICLE	PRICE	EXT.
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Central Scientific Co.
1700 IRVING PK. RD.
CHICAGO 13, ILLINOIS



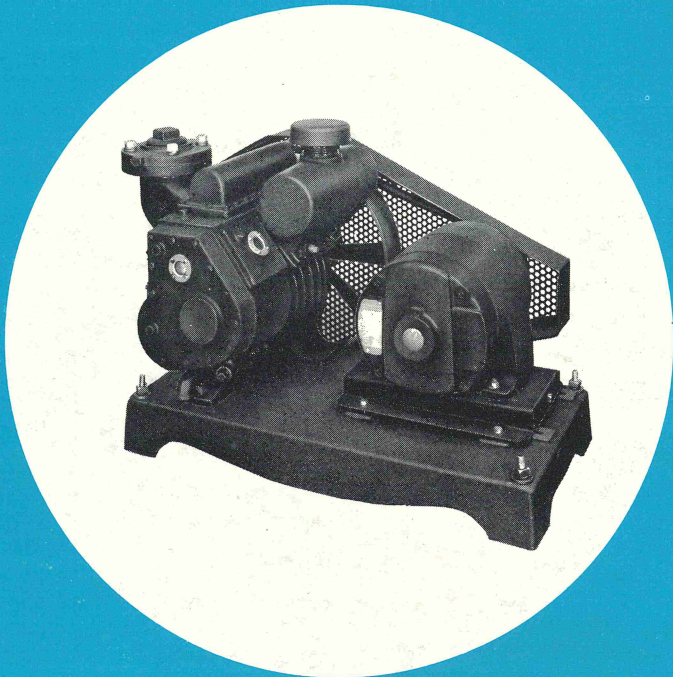
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mechanical vacuum pumps

A COMPLETE LINE OF HIGH VACUUM PUMPS, GAGES, SYSTEMS, & COMPONENTS

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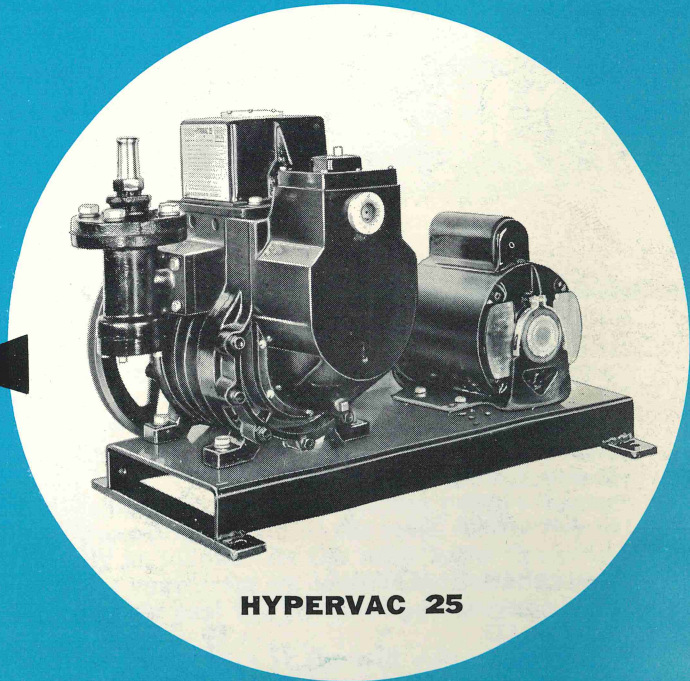
CENCO HYPERVAC 100



The largest in the famous Cenco family of high vacuum pumps, the Hypervac 100 comes mounted, ready to operate with a 220/440V, 50/60 cycle, 3 phase motor. Its ultimate vacuum is guaranteed at 0.1 micron or better. At atmospheric pressure, rated pumping capacity is 960 liters per minute (660 at 1 micron). Comes complete with oil supply and belt guard. Cenco No. 93033.

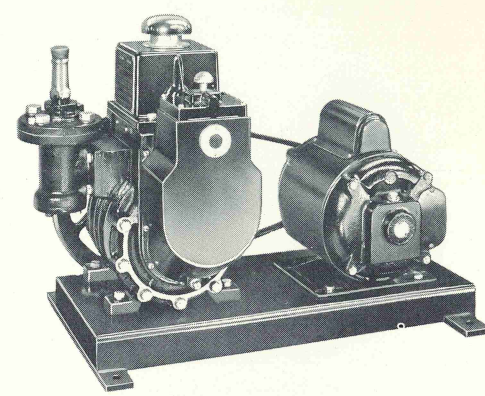
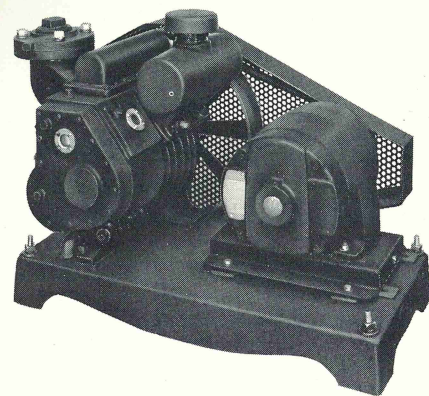
Each \$2326.50

	GUARANTEED VACUUM <i>(microns of mercury)</i>	CAPACITY		BOOKLET
		<i>at atmosphere (liters per min.)</i>	<i>at 1 micron (liters per min.)</i>	
Hyvac	0.3	10	5	320
Hyvac 2	0.1	21	9	321
Hyvac 7	0.1	70	30	
Hyvac 14	0.1	140	60	
Hyvac S14	10.0	140	—	322
Megavac	0.1	57	22	323
Hypervac 23	5.0	240	—	324
Hypervac 25	0.1	264	120	
Hypervac 100	0.1	960	660	
Pressovac	15.0	35	—	325
Blower Pump	3 IN. Hg	35	—	326



HYPERVAC 25

Booklet 324 CENCO HYPERVAC PUMPS operation and maintenance instructions



The largest in the famous Cenco family of high vacuum pumps, the Hypervac 100 comes mounted, ready to operate with a 220/440V, 50/60 cycle, 3 phase motor. Its ultimate vacuum is guaranteed at 0.1 micron or better. At atmospheric pressure, rated pumping capacity is 960 liters per minute (660 at 1 micron). Comes complete with oil supply and belt guard. Cenco No. 93033.

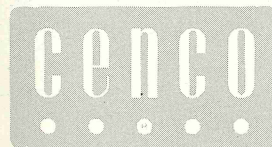
\$2326.50

The Hypervac 25 is the middle model of this Cenco Series in that its pumping capacity at atmosphere is 264 liters per minute (120 at 1 micron) and guaranteed vacuum is 0.1 micron of mercury. The Hypervac 25 comes mounted with a choice of motor ratings or unmounted. Mounted with a 115/230V, 60 cy. ac motor and ready to operate (Cenco No. 93020-1) with a supply of oil, it costs only

\$672.00

All prices F.O.B. our nearest branch as of publication date. Applicable taxes will be added. Exact current prices available on request. Terms: 30 days net.

We have attempted to describe accurately the merchandise listed in this bulletin. Additional information will be gladly given upon request. The company warrants that each item of merchandise sold by it is free from defective workmanship or material upon return of the same to the company office at Chicago, Illinois. This warranty is made in lieu of all other warranties, express or implied, and no other warranty, express or implied, is assumed or will be assumed.



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a division of Cenco Instruments Corporation

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SALES REPRESENTATIVES THROUGHOUT THE WORLD

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1 description

1.1 general

The Cenco Hypervac Vacuum pumps are rotary oil-sealed pumps operating on the principle of the eccentric rotor with spring-actuated moving vane. Hypervac pumps are equipped with backing pumps.

Hypervac 23

A sectional view of the Hypervac 23 pump is shown in Fig. 6. In this figure the rotor is in such position as to divide the rotor chamber into two volumes.

Air is drawn into one volume from the intake and compressed against the vane in the other volume. As the rotor continues to turn, the compressed air is forced out of the rotor chamber past the roller into compartment B.

The backing pump is a reciprocating pump utilizing the reciprocating motion of the vane. The action is essentially as follows: As the rotor turns clockwise raising the vane from its lowest position it begins forcing the air past the roller into compartment B.

The vane carries with it the ball valve block, and the upward movement of this valve block forces the air in compartment A through the spring valve into the oil reservoir. The downward motion of the vane

SPEED-PRESSURE CURVE FOR CENCO HYPERVAC PUMPS

SPEED-PRESSURE CURVE FOR CENCO HYPERVAC PUMPS

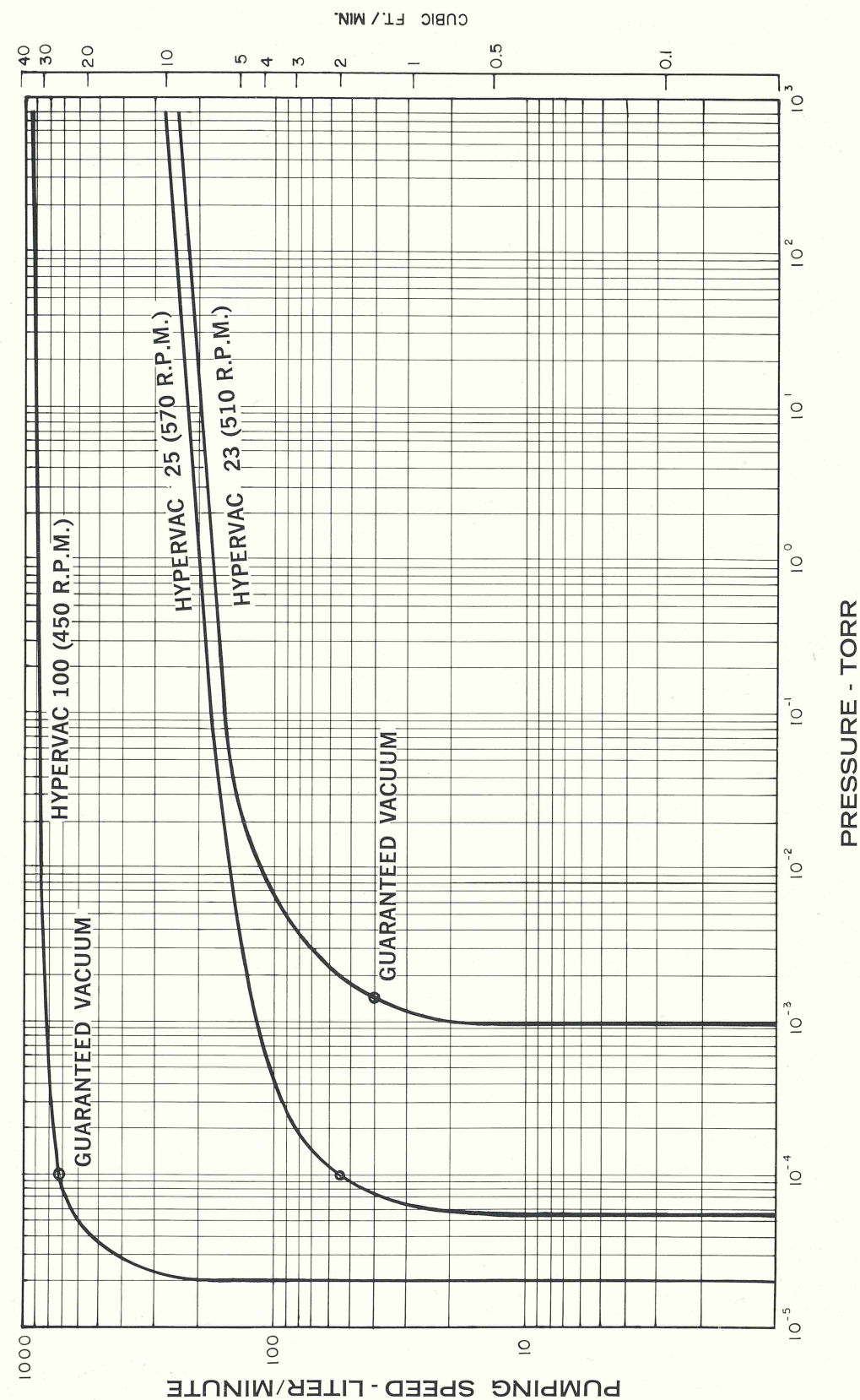
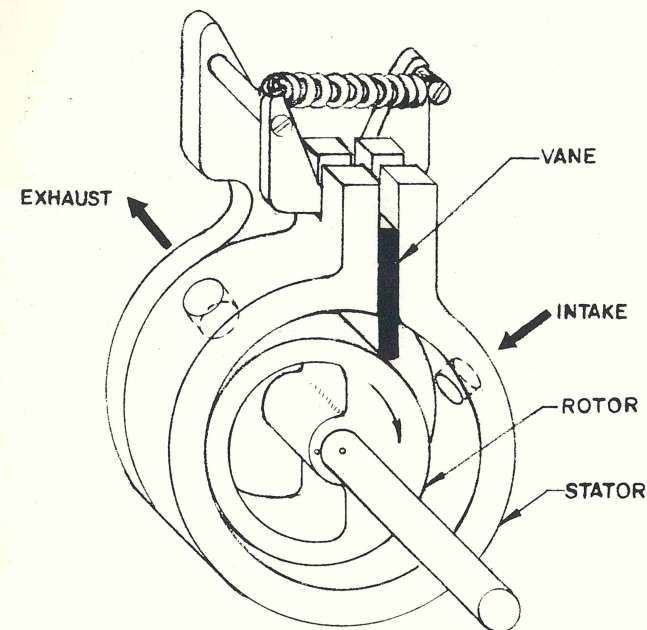


Fig. 1

and ball valve block forces the air from compartment B through the ball valves into compartment A. The roller prevents the return of the air into the rotor chamber. The partial vacuum created in these compartments by the action of the roller and the valves makes possible the attainment of low pressures at the intake of the Hypervac 23.



Hypervac 25

A sectional view of the Hypervac 25 pump is shown in Fig. 7. The Hypervac 25 pump is basically the same as the Hypervac 23 except for the addition of a complete Cenco Pressovac pump which forms an integral part of the Hypervac 25. When the Hypervac pump is started or opened to a large system, the first large quantity of air is forced through a by-pass valve. As the pressure is reduced, this valve closes and the backing pump reduces the pressure in the compartments A and B. Low pressure in these compartments makes possible the attainment of extremely high vacuum at the intake of the Hypervac 25.

Hypervac 100

This is the largest of the Cenco line of high vacuum pumps. Its extremely high rate of displacement and low ultimate pressure make it invaluable for the evacuation of very large volumes not ordinarily possible with commercial pumps unless used with external backing pumps. A complete Cenco Pressovac pump provides the roughing stage and is an integral part of the pump.

1.2 pump data

The speed-pressure characteristics of the Cenco Hypervac Pumps are shown in Fig. 1. Additional pump data are as follows:

Hypervac Pump Model	23	25	100
Pump speed (rpm)	510	570	450
Capacity at atmospheric pressure (liter/min.)	240	264	960
Capacity at 1 micron (liter/min.)	—	120	660
Guaranteed vacuum (microns of mercury)	5.0	0.1	0.1
Merit Factor (%) ¹	—	45	69

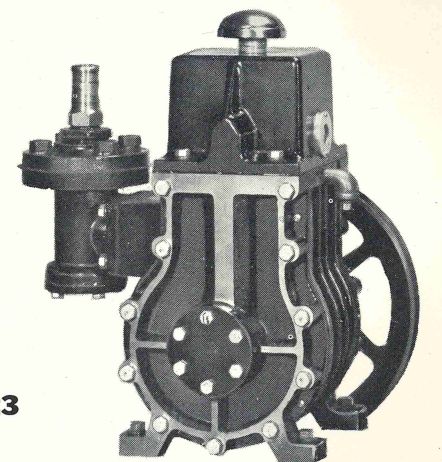
¹ The merit factor is the ratio of the pumping speed at one micron to the pumping speed at atmospheric pressure.

1.3 unmounted pump

The unmounted Hypervac 23 and Hypervac 25 pumps are supplied with a grooved pulley and a sub-base.

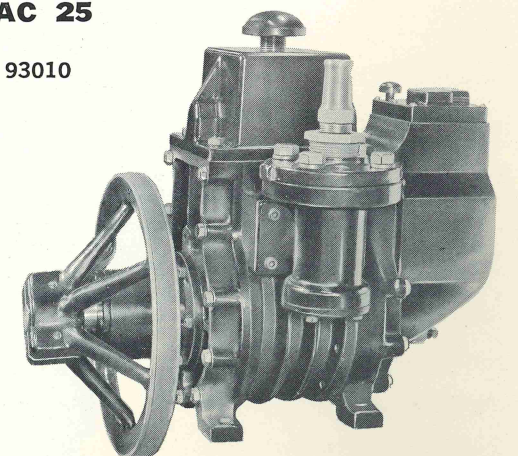
HYPERVAC 23

Cenco No. 93001



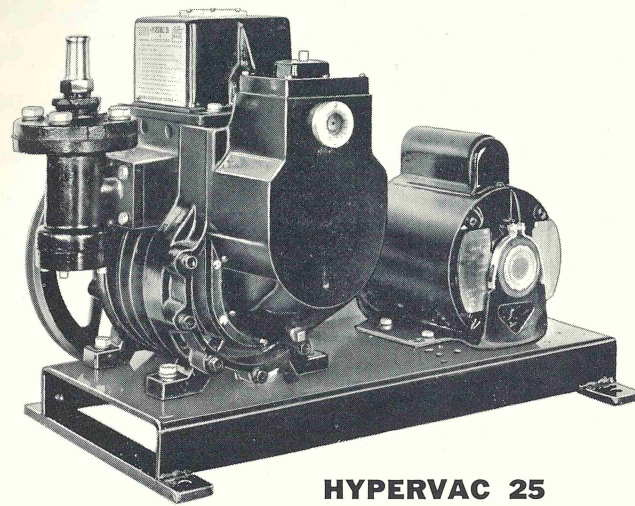
HYPERVAC 25

Cenco No. 93010



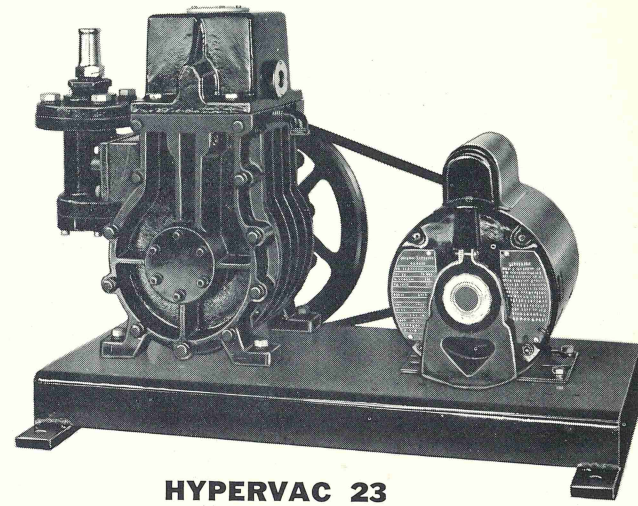
1.4 pump, mounted with motor

Mounted Hypervac pumps are assembled on a steel base and supplied with motor and a belt drive.



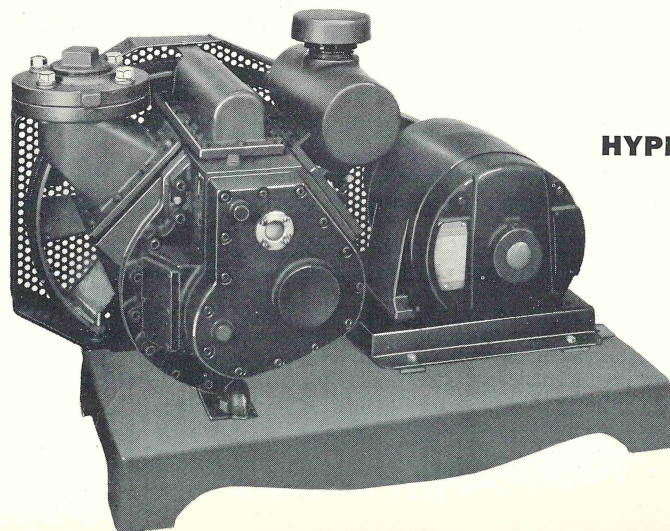
HYPERVAC 25

The Hypervac 100 pump is mounted on a base and supplied with a motor, belt drive and a belt guard.



HYPERVAC 23

Cenco Cat. No.			Motor Rating
Hypervac 23	Hypervac 25	Hypervac 100	
93006-1	93020-1	————	115/230 V., 60 cycle 1 phase
93006-3	93020-3	————	115 V., DC
93006-5	————	————	115/230 V., 25 cycle 1 phase
93006-7	93020-7	————	115/230 V., 50 cycle 1 phase
93006-10	93020-10	————	115/230 V., 60 cycle 1 phase, explosion-proof
93006-18	93020-18	93033	220/440 V., 60 cycle 3 phase
93006-23	93020-23	————	without motor
0.5 hp motor	0.75 hp motor	2.0 hp motor	



HYPERVAC 100

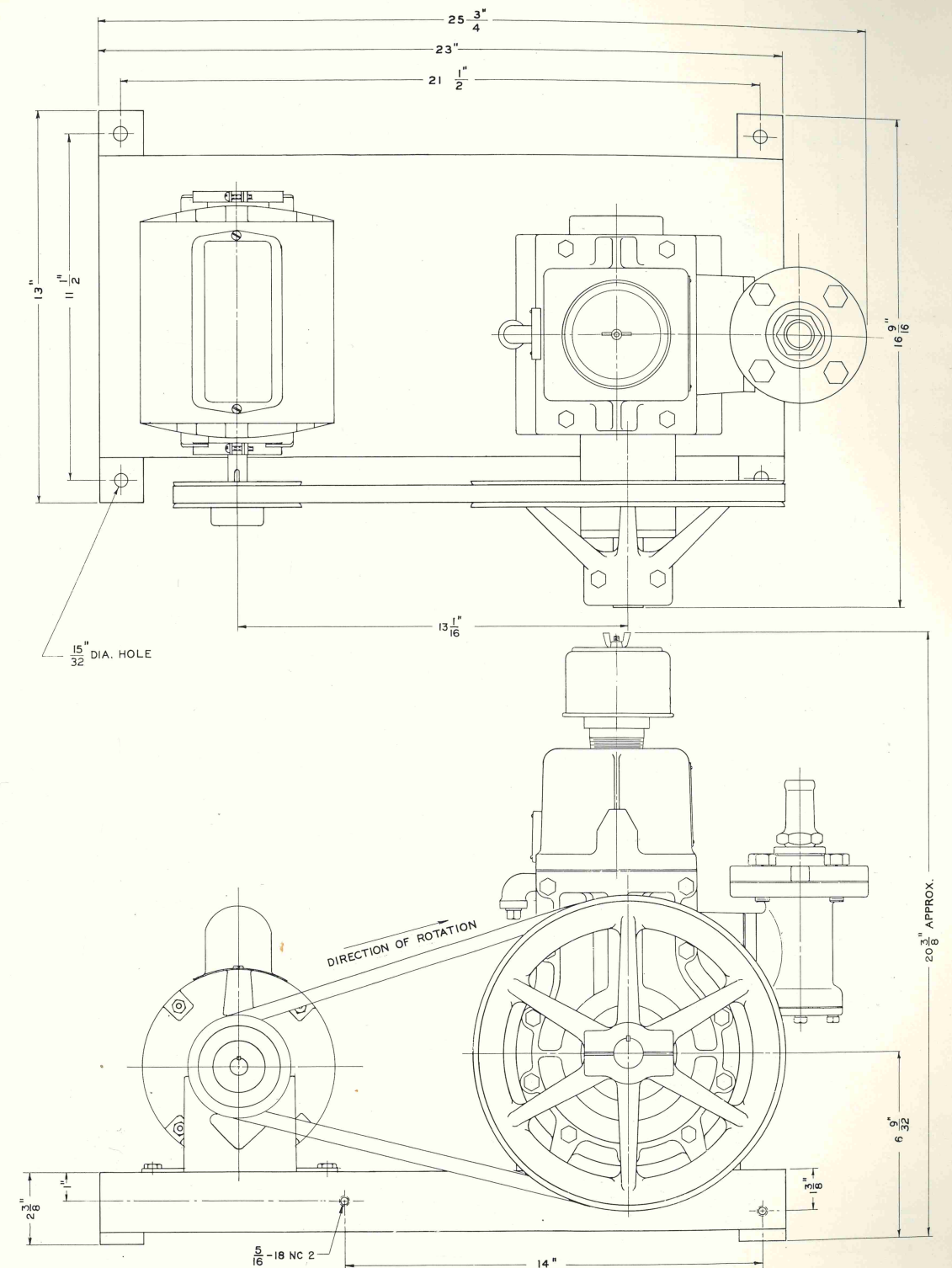


Fig. 2, outline of Hypervac 23 pump

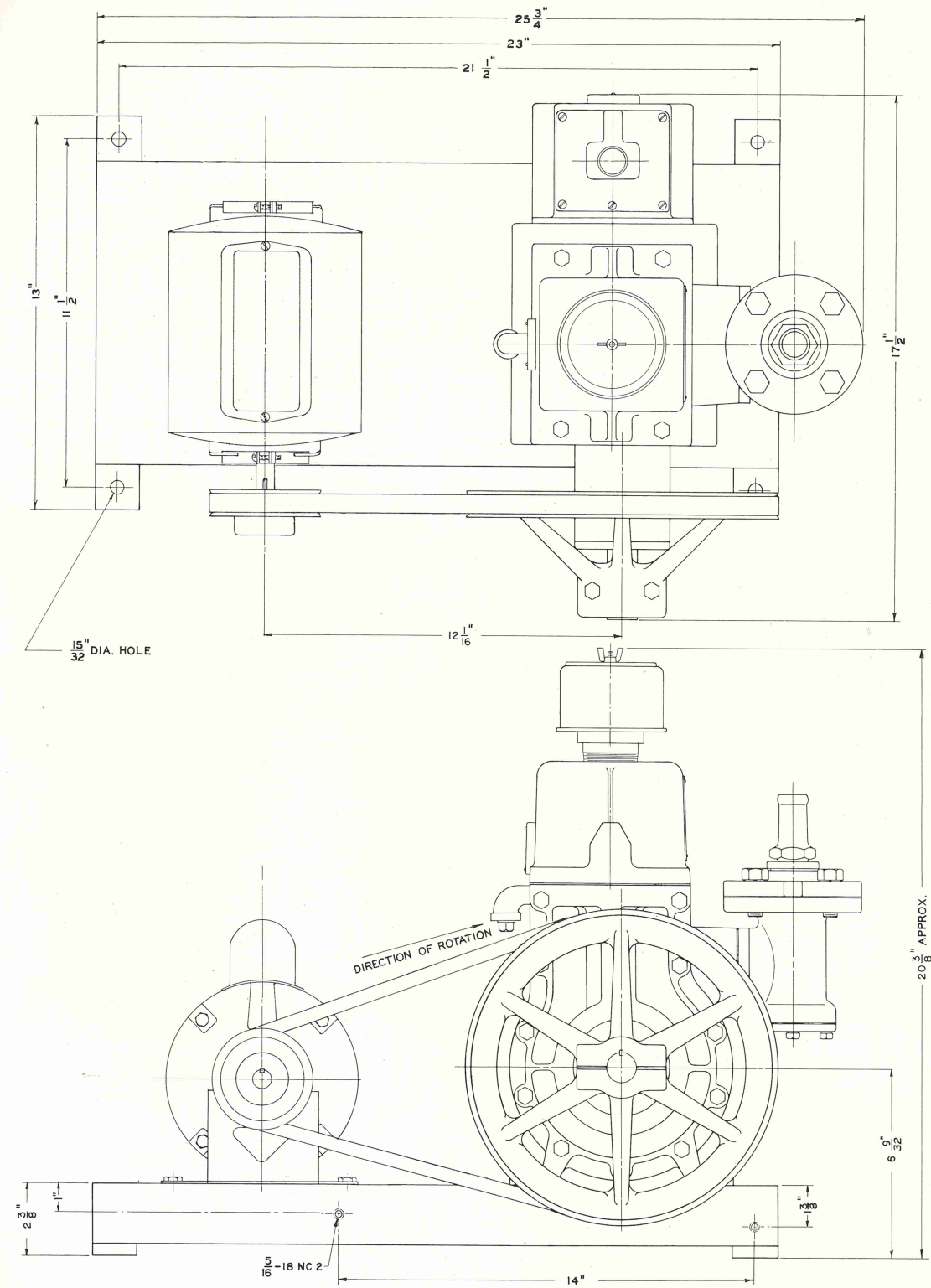
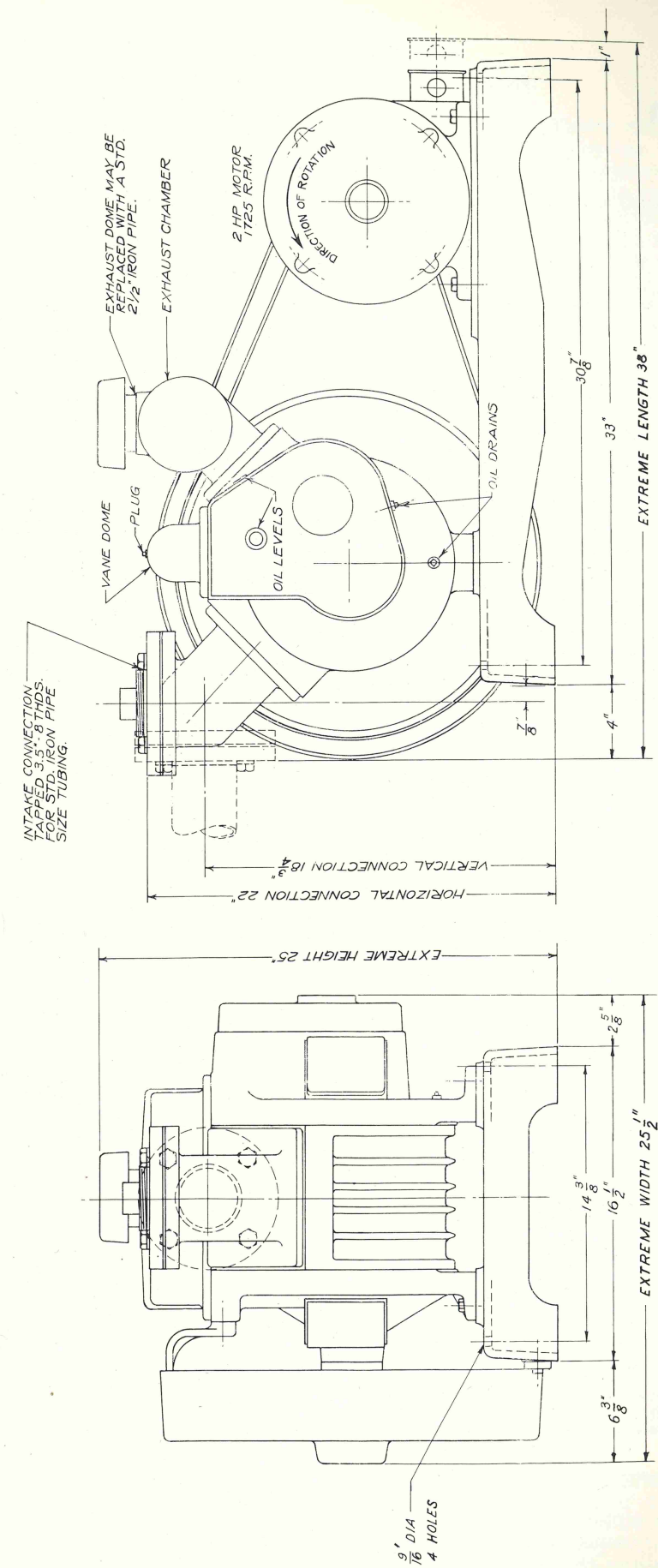


Fig. 3, outline of Hypervac 25 pump



TOTAL WEIGHT APPROX. 600 LBS.

Fig. 4, outline of Hypervac 100 pump

2 installation

2.1 mounting

If the mounted pump is obtained, the pump is immediately ready for use.

If an unmounted pump is obtained, provisions should be made for bolting the sub-base to the floor or, if used in a movable unit, to the frame. When electronic equipment is attached to the same frame, shock mounts should be installed so that vibrations from the motor or pump will not be transmitted through the frame.

A belt drive connects the motor with the pump. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump. The major dimensions of the pumps, pump bases and motors are given in Figs. 2, 3 & 4.

The Hypervac pumps should be operated in an open room as they are air cooled pumps.

2.2 motor connection

In all cases, connect the motor to a powerline of the voltage, frequency and phase as indicated on the nameplate of the motor. The powerline should be heavy enough to carry the current required without an undue drop in voltage. Fuses provide short circuit protection only for the power supply line and do not protect the motor from overload. It is recommended that a suitable motor starting switch with motor overload protection be used for all permanent installations.

Connect the motor to rotate the pump in a clockwise direction as viewed from the pulley end of the shaft.

For correct selection of the fuse, consult the list below:

Cenco Pump No.	Current at full load (amperes)			Max. fuse rating (amperes)		
	at 115V	at 220V	at 440V	at 115V	at 220V	at 440V
Cenco						
93006-1	6.6	3.3	—	25	15	—
93006-3	4.4	—	—	15	—	—
93006-5	6.2	3.1	—	25	15	—
93006-7	7.4	3.7	—	25	15	—
93006-10	7.8	3.9	—	25	15	—
93006-18	—	1.7	0.9	—	15	15
93020-1	10.2	5.1	—	30	15	—
93020-3	6.6	—	—	20	—	—
93020-7	11.6	5.8	—	40	20	—
93020-10	10.8	5.4	—	35	20	—
93020-18	—	2.6	1.3	—	15	15
93033	—	6.0	3.0	—	20	15

2.3 vacuum connections

During shipment the intake nipple of the Hypervac Pump is closed to prevent entrance of foreign matter into the pump. In handling the pump, similar precautions should be exercised.

When connecting the pump to the system to be evacuated, extreme care must be taken to eliminate leakage. All connections should be as short as possible, and of large diameter to reduce molecular friction. When the pump is operating in the low micron range, the flow of gas through a tube is substantially molecular in character. At low pressures, the gas removed from the system is confined largely to those molecules which, because of their kinetic energy of agitation, happen to hit the intake of the pump when the cylinder of the pump is open to the intake. The conductance of various size tubes can be calculated by means of the Cenco VacuRule, Cenco No. 94008, or may be determined from Fig. 5, in which $(L + \frac{1}{3} D)$ is plotted against Z, the conductance in cubic centimeters per second. L and D are the length and inside diameter of the tubes in centimeters.



Typical Cenco Vacuum Connectors

The net speed of the system then may be found by the following relationship:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pump speed taken from Fig. 1 and Z is the conductance of the tubing. The time required to evacuate a vessel of volume V is given by the formula:

$$T = \frac{2.3 V}{S} K$$

where T is the time in seconds, V the volume expressed in liters, and S the average speed of the pump expressed in liters per second over the range from atmospheric to the desired final pressure. The factor K has values of 4, 5 or 6. The factor 4 is used if the final pressure is 100 microns, 5 for 10 microns and 6 for 1 micron.

If metal piping is used, it is best to solder or braze all connections. When threaded pipe joints must be used, the threads should be as perfect as possible. In such a connection, screw the members together several turns, and then apply Glyptal to the exposed threads before screwing together tightly. Allow the Glyptal to dry several hours before starting the pump. If flanged connections are used, flat or O-ring gaskets made of rubber or Neoprene should be used between the flanges to eliminate leakage. Place a thin coat of oil on the "O" ring before using.

Cenco manufactures an extensive line of couplings, connectors and accessories for use in high vacuum systems (see Cenco Booklet 327). Some of these are:

Cenco No.	Name	For Tubing	Size Range
94226	straight through	glass and/or metal	3/8" - 1"
94235	straight through	metal and/or rubber	1/4" - 2"
94228	reducing	glass and/or metal	3/8" - 1"
94230	connectors	metal-to-glass	3/8" - 1"
94240	caps	for 94235	1/4" - 2"
94245	nipples	rubber	3/8" - 1 3/16"

Hypervac 23 and Hypervac 25 pumps are supplied with intake nipples to which vacuum connections may be made. For applications where the highest vacuum is not necessary, high vacuum rubber tubing may be used and forced over the intake nipple in connecting the system to the pump. Rubber tubing connections should be kept as short as possible and made with an extra heavy wall gum tubing, such as No. 18204, which has been compounded specially for vacuum work. All connections to metal or glass tubing should fit snugly and both members should be coated with vacuum stopcock grease. By removing the nipple and reducer, a 1 1/4 inch I.P.S. pipe may be threaded into the flange. To insure a vacuum-tight joint, use Glyptal, Cat. No. 10021, on the threads. If the flange is removed, be sure in replacing to use the Koroseal gasket with a thin coating of high vacuum stopcock lubricant on both sides. Do not remove the intake trap from the pump.

The Hypervac 100 pump intake is machined to receive a standard 3 inch cast iron flange. This flange is included with the pump and is attached using a Koroseal gasket. If the flange is used, the gasket should be given a light coat on both sides with a high vacuum stopcock lubricant. Care should be used in attaching metal tubing to the intake so as not to disturb the other joints on the intake to the pump. Use a sealing compound such as Cenco No. 10021 Glyptal on the threads. A short, large diameter connecting tube is essential for rapid evacuation at low pressures. For maximum pumping speed at low pressure, three-inch inside diameter tubing is recommended. As supplied, the intake casting is assembled for a vertical connection. The intake casting may be arranged for horizontal connection if desired. Remove the screws holding the casting to the pump, rotate the casting 180° and reassemble. Use high vacuum stopcock lubricant on the Koroseal gasket. Be sure to tighten the screws uniformly. In case large quantities of air are to be passed through the pump, a two and one-half inch pipe may be attached to the exhaust chamber and extended outside the pump room.

2.4 valves

Metal vacuum valves and glass stopcocks are employed generally in the connecting line between the pump and the system to provide a means of connecting the vacuum gage and for vacuum release when stopping the pumping. When metal pipes are used for the line, a high-vacuum valve such as No. 94551 is recommended.

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of testing the pump and system for leaks by the "pressure rise" method without disconnecting the pump from the line.

2.5 traps

Extreme care must be taken to prevent solid particles from reaching the intake of the pump. They will score the working parts of the pump and reduce its efficiency.

The intake of Hypervac pumps is protected by means of a wire gauze. This screen prevents large particles from entering the pump chamber. To prevent small solid particles, particularly dust, from being admitted to the pump, a suitably constructed trap should be used.

If corrosive vapors are in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor from the pump from entering the system.

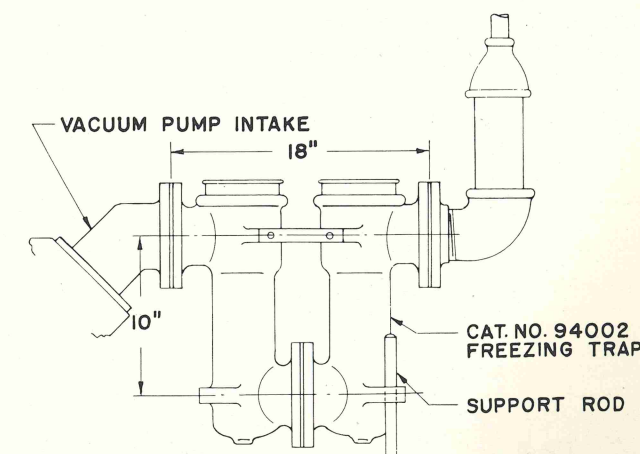


Fig. 9 Two section No. 94002 Freezing Trap connected to Hypervac 100 pump.

For use with the Hypervac 100 pump to freeze large quantities of water or other vapors, a Cenco No. 94002 Freezing Trap is suggested. One or two sections of this freezing trap may be used. Figs. 9 & 10 show the use of this freezing trap and suggested methods for connecting it in the vacuum system.

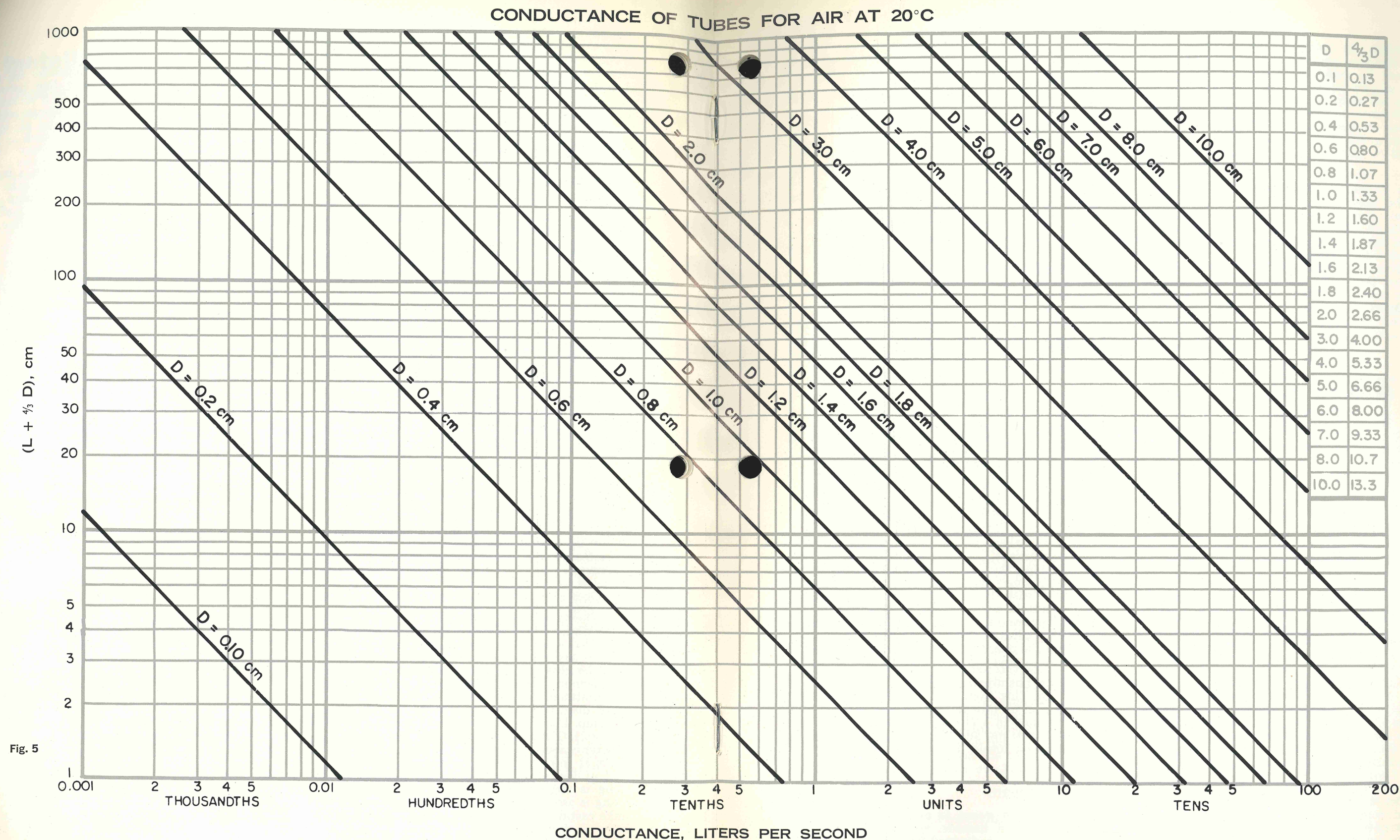


Fig. 5

TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain pumping speed (S) as large as possible, the tube conductance (Z) must be very large as compared with the speed of the pump (S_1), as is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} S_1$$

Since at best (S) is only a fraction of (S_1), the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance (Z), shown in liters/sec., is plotted as abscissas against the quantity ($L + \frac{4}{3}D$), in cm., as ordinates. In addition to the parameter D, the value of $\frac{4}{3}D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm long, having a diameter of 2 cm, is required. From the table, for D = 2, it is seen the $\frac{4}{3}D = 2.66$ cm. Referring to the curve, for D = 2 the conductance corresponding to the ordinate equal to 50 + 2.66, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines, spaced logarithmically, conductance of tubes having other diameters than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely $\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$ where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

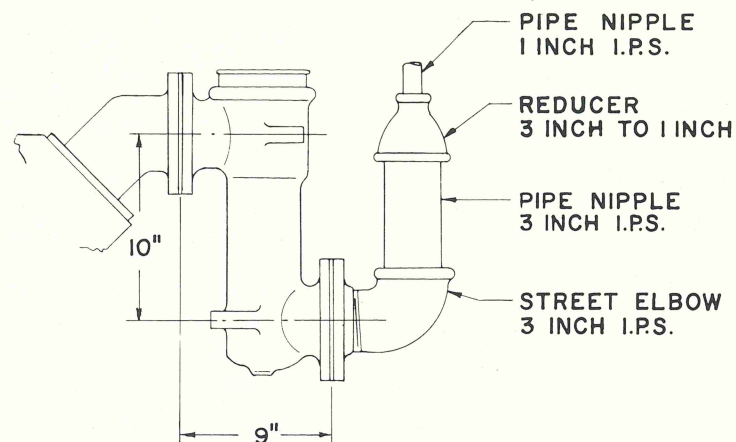
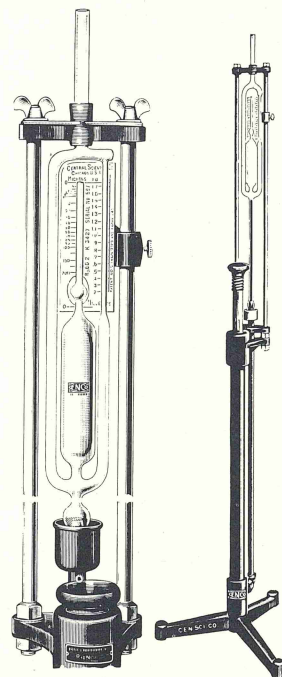


Fig. 10 One section No. 94002 Freezing Trap connected to Hypervac 100 pump.

2.6 gages



94151
Enlarged view of head only at left.

The types of high vacuum gages commonly used in a system employing a Hypervac pump are the McLeod, Pirani, Discharge, and Thermocouple gage. A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0001 mm Hg to 1.6 mm Hg (0.1 microns Hg to 1600 microns Hg). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint. The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 microns and from 1 to 50 microns of mercury. The Thermocouple gage permits measurements in the range from 1 to 1000 microns of mercury. The Discharge gage operates within the range of 0.001 to 20 microns of mercury.

2.7 oil

The Hypervac pumps are shipped with oil inside the pump to protect the working parts, especially if the pump should be stored for some time after receipt before being put into service. Additional oil is supplied with the pump. The following table is a summary of the required oil quantities and oil supply for the Hypervac pumps.

Pump Model	Quantity of Oil required	Quantity of Oil Shipped Inside Pump	Quantity of Oil Shipped Separately
Hypervac 23	1 pint	1 pint	1 quart
Hypervac 25	2 quarts	2 quarts	2 quarts
Hypervac 100	4 to 5 quarts	2 to 3 quarts	2 quarts

To prevent leakage of the oil, the exhaust port is closed in shipment. On the Hypervac 23 and Hypervac 25 pumps, the exhaust port is covered with a plug. Before operating the pump, unscrew this plug and replace with the exhaust filter which should be screwed into the threaded hole on the pump dome. On the Hypervac 25 pump, it is also necessary to remove the plug in the backing pump cover and to replace the plug with a small exhaust dome cap.

On the Hypervac 100 pump, remove the plug from the exhaust chamber and insert the exhaust dome. Remove the plug from the intake and pour about 1½ quarts of oil into the intake while turning the pump by hand in a clockwise direction. After the pump is operating, add oil if necessary to obtain the proper oil levels. For proper lubrication see section 3.

2.8 belt guard

A well designed guard is a desirable protection against personnel hazards, and also protects the pump from damage caused by objects becoming entangled in the belt or pulley. Hypervac 23 and Hypervac 25 pump bases are drilled to receive the guards, and each guard is sold ready for mounting. The order number for this belt guard is given in Paragraph 5.2. Hypervac 100 pumps are supplied with a belt guard.

3 operation

3.1 general

If the pump has been installed as described in section 2, the pump is ready for operation. In continued service only proper lubrication has to be maintained. The sealing oil automatically lubricates all bearings and moving parts of the pump. Lubricate the motor before starting. Add oil slowly to each oil reservoir until the level of the oil rises sufficiently high to cause the oil to flow from the overflow holes. Relubricate every 2000 to 3000 hours with a medium weight mineral oil such as light automobile engine oil (S.A.E. 20-30).

The Cenco Hypervac pumps are air cooled pumps designed to operate in an open room. The air currents produced by the drive pulley are adequate to keep the pump at proper temperature. The safe operating temperature is 70°C or below. The pump functions most efficiently at its normal operating temperature, 60°C to 70°C; it is well to allow it to reach this temperature before expecting best pumping efficiency.

When oil has become contaminated it should be changed. The frequency of oil change is dependent upon the service of the pump. An oil change may be needed only once in six months or longer if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosion and easily condensable vapors enter the pump.

3.2 oil change on Hypervac 23 and Hypervac 25 pumps

To drain the pump remove the drain plug. Turn the shaft several revolutions to force out any remaining oil. Flush with clean flushing oil, No. 93060, at least once and then refill with new Hyvac Oil No. 93050.

In refilling, pour the oil into the pump through the exhaust port, turning the pump several times by hand as the oil is poured in. Pour into the pump a little less than the quantity required for that pump. Run the pump for 10 to 15 minutes before adding additional oil. Then add oil, a small amount at a time, until the oil level is approximately at the center of the oil level gage when the pump has been operating on a closed system for at least one-half hour. When the oil level has been established, replace the vent cap. Maintain the oil level within the range of the oil level gage at all times, adding more oil when necessary.

3.3 oil change on Hypervac 100 pump

Remove the screw plug at the top of the vane dome. Remove the two drain plugs at the bottom of the end castings. See Fig. 13. The one on the under side of the overhanging casting drains the outer compartment and one just above the support drains the inner compartment. Turn the wheel several revolutions to clear the pump of oil.

To refill, replace the two drain plugs, sealing each with Glyptal. Refill with four and one-half quarts of No. 93055 Hyvac Oil; no other oil should be used. About three quarts of this oil may be poured into the inner compartment through the opening on the top of the vane dome, the remainder into the outer chamber through the exhaust port. The wheel may be turned slowly while filling the inner compartment. Replace the screw plug in the vane dome, sealing same with Glyptal.

If too much oil is in the pump, remove a small quantity from the outer compartment adjusting until the oil levels reach their normal condition. When both oil levels are low, add oil thru the exhaust dome until the proper levels are reached. It should be remembered, however, that if the pump has been standing inoperative for a considerable length of time, a great deal of the oil may have gravitated to the cavity within the large rotor of the pump; consequently, the pump must be in operation for a considerable length of time on a closed system before the oil will have returned to the outer compartment.

3.4 lubrication system of Hypervac 100 pump

The oil in the pump is automatically distributed and separated into two compartments. The pressure in these two compartments is different. The outer compartment, in which the proper oil level is shown by the sloping oil level window on the exhaust side, is at atmospheric pressure. The inner compartment, in which the proper oil level is shown by the oil level window on the end of the pump, is held by the backing pump at a pressure of several microns.

When the pump is started or opened to a large system, the first large quantity of air is forced through the by-pass valve. As the pressure is reduced, this valve closes and the backing pump reduces the pressure in the inner compartment. The reduction in pressure outgasses the oil, causing it to foam. The foam usually completely covers the window and continues to do so until the pressure is reduced to a few microns and then gradually disappears. This outgassing process, with the accompanying foam of the oil, indicates normal operation of the pump. The time required for this sequence of events is a function of the size of the vacuum system and the temperature of the pump mechanism and may require from one to several minutes.

An hour or two of operation of the pump may elapse before the oil levels become normal, which are from the middle to the top of the window of the outer chamber and visible in or below the window of the inner chamber. The oil in the inner chamber should stand just below the small hole visible in the plate seen through the window on the side of the pump. The fact that considerable time is required for the oil levels to adjust themselves does not influence the operation of the pump nor affect the wear of the pump mechanism.

Fig. 6

Fig. 7

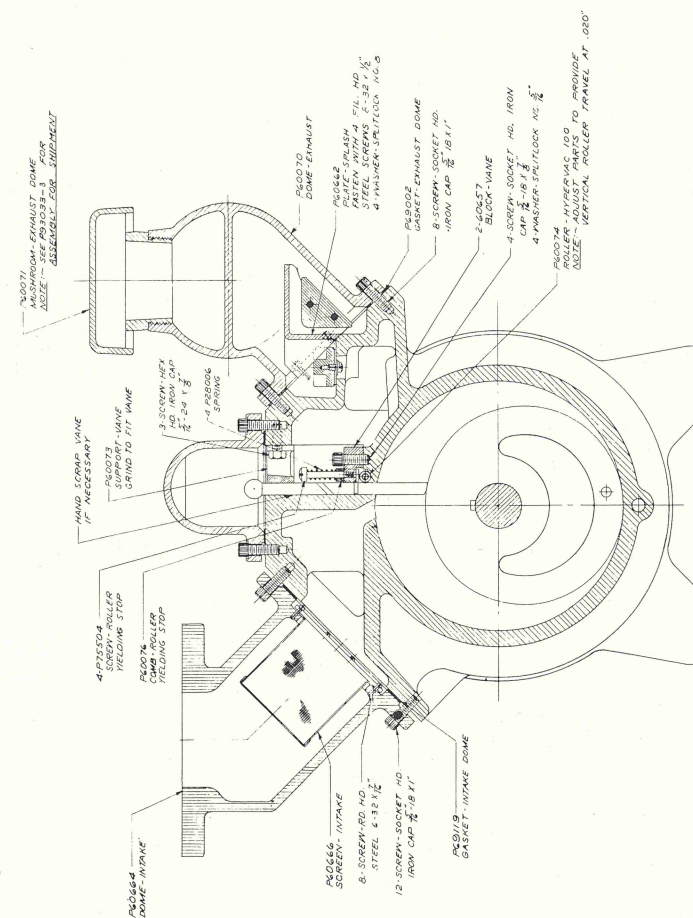


Fig. 8

If the oil levels are *both* low, that is, differ from the indications mentioned above, a small quantity of oil should be added to the pump through the exhaust dome. If, after one-half hour's operation, *both* oil levels are still low, add a small quantity of oil. Proceed as necessary to establish the proper oil levels, keeping in mind that when the outer chamber shows an excess of oil, the inner chamber may show a deficiency.

A connection between the inner and outer compartments is established in three ways: through a large by-pass valve, a small float valve, and the backing pump mechanism. Both valves are attached to the main pump casting and are covered by the exhaust chamber. The backing pump is attached to the side of the main pump casting, its intake being visible through the oil level window for the inner compartment.

When large quantities of air or gas pass through the pump, the large by-pass valve is forced open, permitting air to flow from the inner to the outer compartment. Along with this flow of air, a quantity of oil may be transferred. When this occurs the oil level windows show an excess of oil in the outer compartment and a deficiency in the inner compartment. The excess oil in the outer compartment

opens the small float valve and the normal levels are gradually established.

When an excess of oil collects in the inner compartment, the oil level will stand high and will enter the intake of the backing pump through the small hole in the plate which is seen through the window on the side of the pump. The backing pump transfers this excess oil from the inner to the outer compartment, aiding in the maintenance of normal oil levels.

In view of the means used to establish proper oil levels, it is clear that too much oil in the main pump will necessitate a continuous transfer of oil from the inner to the outer compartment through the backing pump and from the outer to the inner compartment through the float valve. When this condition occurs, the pump will not function efficiently, since the backing pump is required to handle too much oil and the float valve releases "atmospheric" oil continually into the inner compartment. Hence, the oil levels should be low rather than high under normal operating conditions on a closed system. This further emphasizes the point that in adding oil to adjust the oil levels, small quantities should be added at a time.

4 maintenance

4.1 general

The maintenance requirements of the Cenco Hypervac pump will vary with application. Proper lubrication is the most important factor in securing reliable performance (See section 3).

If a pump is connected into a normal leak-free system, there should be no condition which should cause the pump to malfunction that cannot be remedied by simple adjustments. If a pump does not function properly, the cause usually can be attributed to a broken spring, a sticking vane or worn valve release and not a misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the function of the various moving parts tends to form a more perfect seal. In normal use, therefore, where no corrosive vapors are encountered, it is reasonable to expect that there will be no decrease in the efficiency of a pump over a period of several years.

4.2 shaft seal replacement

The shaft seal is shown in Figs. 6 and 7 for the Hypervac 23 and Hypervac 25 pumps and in Figs. 11 and 12 for the Hypervac 100 pump. In normal operation the seal housing is filled with oil. This oil prevents leakage of air into the pump. The shaft seal prevents leakage of this oil from the seal housing. Oil for the seal housing is supplied from the pump through the oil duct. The oil comes from the exhaust dome chamber and is under atmospheric pressure.

On the Hypervac 25 pump there are two shaft seals, one as described above and the other being on the backing pump end. This latter seal is immersed in the same oil as the backing pump. It is not recommended that any attempt be made to replace or repair the shaft seal-backing pump end. The pump should be returned to the factory for such repair.

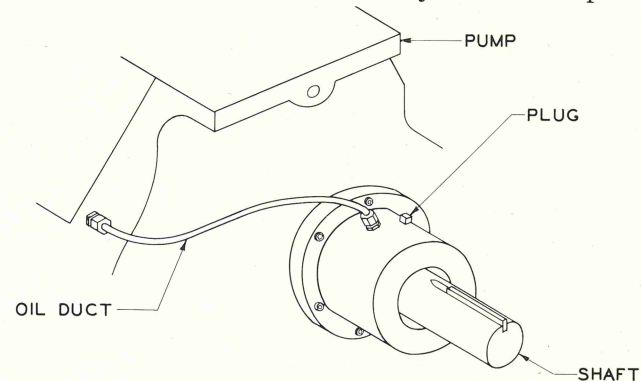


Fig. 11

The two ends of the pulley end shaft seal are symmetrical and the seal functions essentially as follows: the two seal rings prevent oil leakage between the steel floating seat and the seal housing guide on one end and between the steel floating seat and the seal housing on the other. The rubber bellows grip the shaft and cause the central portion of the shaft seal to rotate with the shaft. The rubber bellows also prevent oil seepage along the shaft. The two carbon seal rings rotate with the shaft and are held against the steel floating seat by the seal spring. They form the principal seal against a leakage of oil from the seal housing and leakage of oil and air into the pump.

It is expected that the pulley end shaft seal will perform satisfactorily with a long life. Probable replacements may be the carbon seal rings and the rubber seal rings. In case of oil leakage from the shaft, the shaft seal housing must be removed and the shaft seal examined for worn parts.

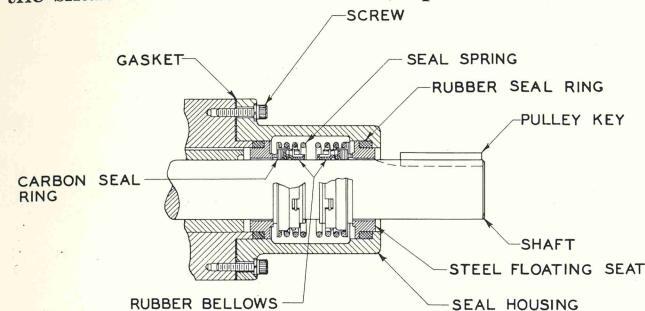


Fig. 12

In order to inspect or repair the pulley end shaft seal, proceed as follows: remove the pulley, drain the oil from the pump, place a pan under the seal housing to catch the oil. On Hypervac 100 pumps, disconnect the oil duct, plug the hole where it connects to the pump to prevent leakage of oil from the outer compartment, or drain the oil from the compartment. Remove the screws holding the seal housing to the pump. Remove the seal housing. It may be necessary to tap the housing sharply to break the sealing compound. Note carefully the relative position of the various parts of the seal. Examine the parts carefully and replace any that appear worn.

In reassembling, proceed as follows: clean the sealing surfaces of the housing and of the pump thoroughly. Place a rubber seal ring and a steel seat in both the housing and the housing guide. Carefully force the central part of the shaft seal comprising the two carbon seal rings, the seal spring and bellows over the shaft. Coat the sealing surfaces of the housing and pump with a sealing compound such as Glyptal. Just before replacing the housing, lubricate the shaft and make certain that the carbon ring is in contact with the steel seat in the housing guide and the shaft spring is fully extended. Slip the housing over the shaft and secure it in place with the screws. This procedure compresses the shaft seal spring and makes certain that each carbon ring is in contact with its steel seat.

Before starting the pump, remove the vent screw to release the air. On Hypervac 100 pumps reconnect the oil duct. Fill the pump with oil. Turn the pump if necessary to make oil flow through the oil duct and fill the seal housing. Replace the vent screw when the housing is filled with oil. It is recommended that this vent screw be removed once every six months to allow any air that may have collected in the housing to escape and to permit the housing to fill with oil.

4.3 exhaust valve

The exhaust valve on the Hypervac pumps is very important in attaining the rated vacuum of these pumps.

4.3.1 spring valve of the Hypervac 23 pump

To examine the spring valve, drain the oil and remove the exhaust dome. The spring valve block will be seen beside the vane. Remove the two screws holding the valve spring support on the block. The valve spring and flat spring valve may be removed with a knife blade. If broken or defective, replace the valve spring and flat valve. Before replacing, examine the seat in the valve block to make certain that it is smooth and clean. Be sure the flat valve is flat so that the valve spring will cause it to close. Reassemble and refill with oil.

4.3.2 by-pass valve of the Hypervac 25 pump and Hypervac 100 pump

To determine if the by-pass valve is the cause of malfunction, drain the oil from the Hypervac 25 pump or from the outer compartment of the Hypervac 100 pump and remove the exhaust dome. Remove the wire which prevents the guides from rotating in their sockets. Remove one guide by unscrewing. Examine the valve for any defects, damage or wear to the Koroseal facing. Renew the Koroseal facing if necessary. Replace the parts making sure the valve moves freely on its guides and when seated is not under tension from the springs. The springs should act only as bumpers when the valve lifts. Secure the guides with the wire, replace the dome and refill the pump with the proper amount of oil. If the pump is not producing a satisfactory vacuum and the backing pump shows evidence of continually pumping air, this may be caused by failure of the by-pass valve to function properly. The failure may be due either to broken or defective Koroseal facing on the valve or to the valve not moving properly on its guides. Failure of this valve permits oil to leak from the outer to the inner compartment and the pump, in attempting to restore the levels to normal, pumps oil through the small opening visible through the oil level window of the inner compartment back to the outer compartment. This prevents the backing pump from producing the required vacuum in the inner compartment.

4.4 vane springs

4.4.1 high vacuum stage vane springs

The vane and the eccentric rotor are the essential moving components of the high vacuum stage of the pump. The main vane is enclosed by the exhaust dome of the Hypervac 23 and Hypervac 25 pump respectively and by the vane dome of the Hypervac 100 pump. (See Figs. 4, 6, 7, 8 and 13). The vane is held in contact with the rotor by means of two coiled tension springs. The upper loops of the springs are hooked over the cross bar attached to the top of the vane. The lower ends of the springs are attached to a U-shaped vane spring support held into cavities of the main casting by means of cap screws.

If one or both of these springs should break, the trouble is usually manifested by the failure of the pump to produce a good vacuum and also a clattering sound within the pump. The sound is caused by the failure of the vane to follow the rotor at all times. Under certain conditions, however, when the pump is warm and working against a closed system, the vane will follow the rotor even with both springs broken.

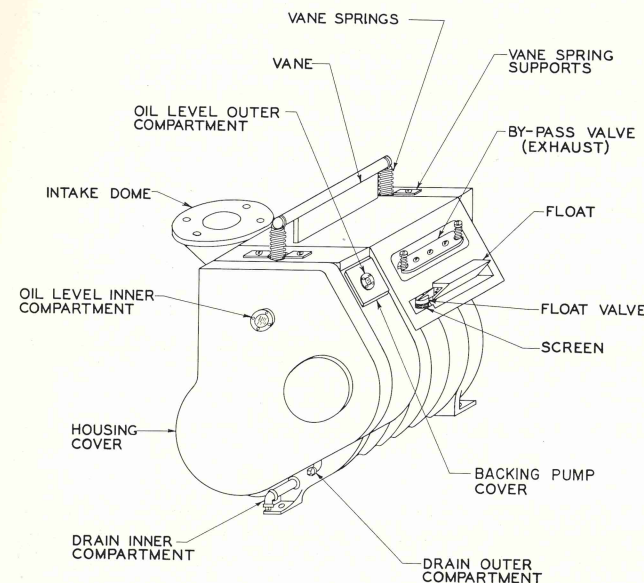


Fig. 13

If there is a basis for suspecting a broken spring, the pump should be stopped and the springs replaced as follows: Drain the oil of Hypervac 23 and Hypervac 25 pumps from the pump through the drain plug. Remove the dome. Turn the main rotor by means of the driving pulley until the vane has travelled to the uppermost limit of its movement, and hold the rotor in that position. DO NOT RAISE THE VANE FROM ITS CONTACT WITH THE ROTOR LEST THE METAL ROLLER WHICH FORMS THE SEAL FOR THE HIGH VACUUM STAGE FALL INTO THE PUMP CAVITY. IT CANNOT BE REMOVED WITHOUT DISASSEMBLING THE PUMP.

The upper end of the broken spring may be unhooked from the vane bar. The lower part of the spring should be removed by first removing the cap screws which hold the vane spring supports in place and then withdrawing the supports. Care should be exercised to remove all broken parts attached to either the vane bar or the support.

To replace the spring on the Hypervac 23 and Hypervac 25 pumps, slip the loop over one side of the U-shaped support and move the spring into its position on the stud. To replace the spring on

the Hypervac 100 pump, unscrew one side of the support from the connecting stud.

Reassemble and insert the support and new spring in the cavity of the main frame. Attach the cap screws and then hook the upper loop of the spring over the end of the vane bar.

It is good practice to replace both springs although only one may be broken.

Replace the dome, using a new gasket. Before assembly the metal sealing surfaces should be carefully cleaned with alcohol or other solvent, and these surfaces and both sides of the gasket should be painted with Glyptal.

4.4.2 backing pump vane springs

If the backing pump cover is removed on the Hypervac 25 and Hypervac 100 pumps, the single-stage backing pump will be exposed. This pump is driven by gears from the main shaft. The pump operates completely immersed in oil. This pump should operate for long periods of time without attention with the possible exception of breakage of the vane spring. If the vane spring breaks, the vane may pound against its rotor producing a clattering sound in this section of the pump. In addition, it may no longer be possible to attain the expected vacuum in the main system.

On the Hypervac 100 pump, as a further indication of a broken spring, the pump may fail to produce a foaming of the oil in the inner compartment when the pump is started.

To replace the spring, stop the pump and proceed as follows: Remove the backing pump cover. Drain oil from the backing pump until the backing pump is exposed. The L-shaped vane lever should be connected to the round grooved stem opposite it by a coil of the tension spring. If this spring is missing, it has broken; while the parts may be found in the lower part of the case, it is not necessary to remove them.

The spring should be replaced by attaching a new coil spring to the stem and L-shaped lever which keeps the vane in place during the operation. In making this replacement, it is good practice to tie a string to the spring until it is in place.

4.5 float valve mechanism of Hypervac 100 pump

The location of the float valve mechanism is shown in Fig. 13. If a continual transfer of oil takes place through the backing pump into the outer chamber when the pump is operating on a closed system, or if the oil level in the outer chamber stands abnormally high for several hours while the pump is operating on a closed system, the float valve may not be functioning properly. There are several possible causes for this condition. The screen which protects the float valve proper may be clogged. The opening of the float valve which admits oil from the outer to the inner compartment may be clogged. The mechanism of the valve itself may be out of adjustment.

The remedy for this condition may be accomplished by draining the outer compartment and removing the exhaust chamber. Clean the screen and, if necessary, remove any foreign matter which may be clogging the opening in the valve. See that the float valve mechanism functions properly and does not bind at any point. On replacing the exhaust chamber, exercise care to see that the gasket does not in any way interfere with the float operation.

4.6 intake screen

If an accident occurs, causing a rush of small and large particles of foreign matter into the intake of the pump, stop the pump immediately. On Hypervac 23 and Hypervac 25 pumps, remove the screen support of the intake trap. On the Hypervac 100, the intake connection of the pump to which the protecting screen is secured should be carefully removed. This will allow the intake screen to be cleaned. After removing all particles, clean with carbon tetrachloride. Clean both sealing surfaces and the gasket before reassembling. Cover both sides of the gasket with a light coat of high vacuum stopcock lubricant and reassemble. Protect the intake of the pump with a clean cloth during these operations.

4.7 belt drive

The belts should be just tight enough to drive the pump when starting. Greater tension will cause excessive wear of the bearings of the pump. To tighten the belts, shift the motor.

4.8 repairs

Simple repairs (replacing spring, etc.) may be done by the user. If shop facilities or an experienced mechanic are available, more extensive repairs may be possible. However, for major repairs or complete overhaul, the pump should be returned to the factory. Request shipping instructions before returning. Some parts are sold only to customers maintaining adequate shop facilities and experienced mechanics. Cleaning and reinstalling old parts, unless badly worn, is recommended as safer practice than attempting to refit new parts without the necessary tools and experience. Vanes are supplied with one side only machined and ground and must be finished to fit the vane slot by the customer if it is impracticable to return the pump to us for repair.

5 replacement parts and accessories

5.1 replacement parts

Part Description	Parts per Hypervac Pump			Part Number
	23	25	100	
Exhaust dome gasket	1	1	—	P35017
Exhaust dome gasket	—	—	1	P69002
Flange gasket	1	1	—	P27066
Vane spring	2	2	—	P28000
Vane spring	—	—	2	P28007
Vane spring for backing pump	—	1	1	P28005
Shaft seal — pulley end	1	1	—	P35256
Shaft seal — pulley end	—	—	1	P35241
Carbon seal ring	2	2	—	P35257
Carbon seal ring	—	—	2	P35242
Trap gasket	1	1	—	P35258
Screen support gasket	1	1	—	P35259
Exhaust valve assembly	1	—	—	P67379
Valve spring	1	—	—	P65412
Flat valve	1	—	—	P65411
Seal, housing cover	1	1	—	P60680
Vane assembly	1	—	—	P67377
By-pass valve assembly	—	1	—	P67368
Valve springs	—	2	—	P28060
Valve gasket	—	1	—	P27067
Cover gasket	—	1	—	P35014
Exhaust valve assembly	—	—	1	P67358
Exhaust vane lining	—	—	1	P69004
Exhaust valve spring	—	—	2	P28012
Float assembly	—	—	1	P67078
Vane dome gasket	—	—	1	P69000
Oil seal, housing end plate	—	—	1	P60078
Roller	—	—	1	P60074
Hand hole cover gasket	—	—	1	P69014
Roller	1	1	—	P60045
Belts	—	—	3	93035
Belt	1	1	—	92020

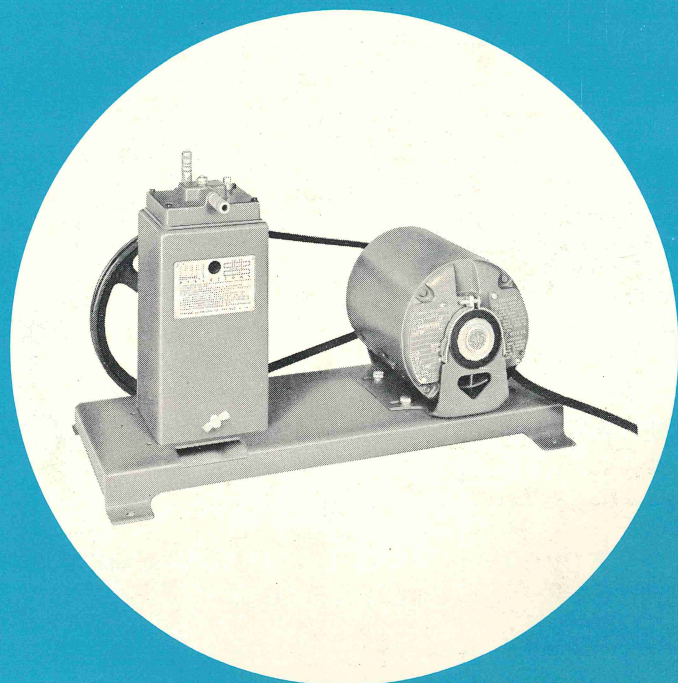


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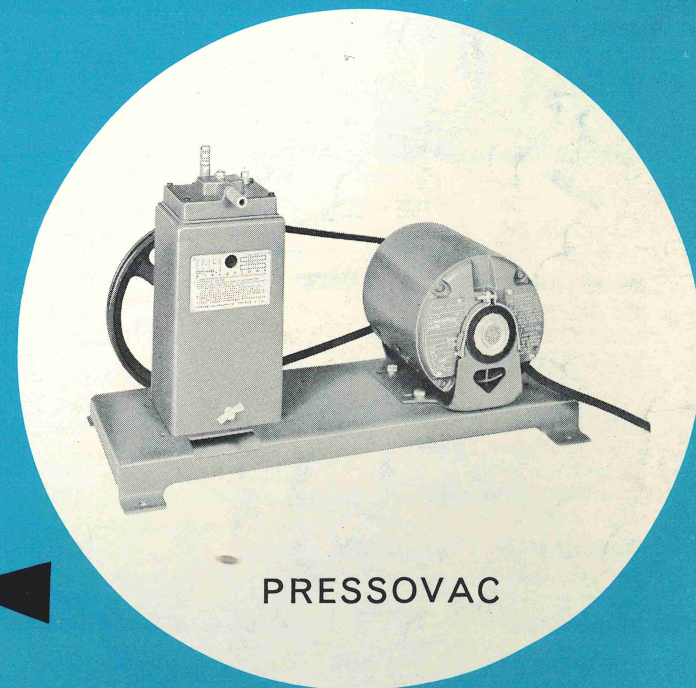
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	GUARANTEED VACUUM (microns of mercury)	CAPACITY		BOOKLET
		at atmosphere (liters per min.)	at 1 micron (liters per min.)	
Hyvac	0.3	10	5	320
Hyvac 2	0.1	21	9	321
Hyvac 7	0.1	70	30	
Hyvac 14	0.1	140	60	
Hyvac S14	10.0	140	—	322
Megavac	0.1	57	22	323
Hypervac 23	5.0	240	—	324
Hypervac 25	0.1	264	120	
Hypervac 100	0.1	960	660	
Pressovac	15.0	35	—	325
Blow Pump	3 IN. Hg	35	—	326



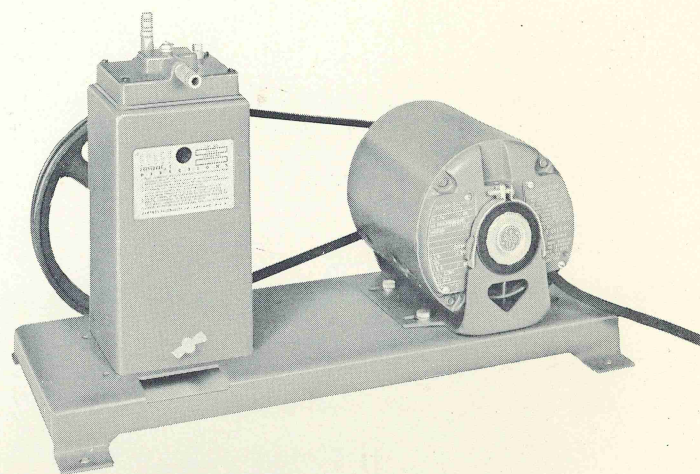
PRESSOVAC

CENCO PRESSOVAC PUMP

Booklet 325 operation and maintenance instructions

A single stage, oil sealed mechanical pump of the moving external vane design for pumping down to 15 microns of vacuum or providing pressure of 10 psi with moderate speeds. The reasonable cost and relatively light weight of the Pressovac make it ideal for lecture room demonstrations in schools and for a backing pump for mercury and oil diffusion pumps in the research laboratory. Comes unmounted or mounted on a substantial base with a wide choice of motors and a pulley, belt, line cord and 3-prong safety plug. Models are also available with a pump plate conveniently attached to the pump body. No. 90510-1 comes with a 115 volt, 60 cycle motor at a price of

\$103.00

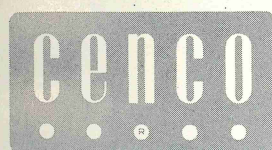


All prices F.O.B. our nearest branch as of publication date. Applicable taxes will be added. Exact current prices available on request. Terms: 30 days net.

We have attempted to describe accurately the merchandise listed in this bulletin. Additional information will be gladly given upon request. The company warrants that each item of merchandise sold by it is free from defective workmanship or material upon return of the same to the company office at Chicago, Illinois. This warranty is made in lieu of all other warranties, express or implied, and no other warranty, express or implied, is assumed or will be assumed.

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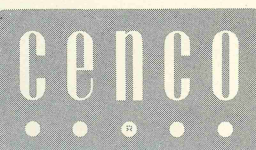
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Central Scientific Co.

a division of Cenco Instruments Corporation

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PRospect 6-1800
TWX-SMVL-MASS 583

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FAirfax 4-2433
TWX-BH 450

HOUSTON 17, TEXAS

6610 Stillwell Avenue
Mlssion 4-1401
TWX-HO 514

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TWX-MTB 3815

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130 Sparks Street
2-1601

1 description

1.1 general

The Cenco Pressovac pump is a single stage adaptation of the original Cenco Hyvac Pump. The Cenco Pressovac pump is specifically designed for moderate vacuum and pressure demands. It is frequently used for lecture demonstrations, for providing backing pressures for many types of mercury and oil diffusion pumps and for general laboratory use where highest vacuums are not required.

The Cenco Pressovac pump is a rotary type, oil-sealed pump operating on the principle of the eccentric rotor with spring-actuated moving vane. Air at atmospheric pressure is forced into a smaller volume by the action of an eccentric rotor with the moving vane always in contact, and is expelled from the exhaust ports. By immersing the entire mechanism in a bath of oil, the oil serves the three-fold purpose of (1) insuring a vacuum tight seal of the stage, (2) serving as a coolant and (3) lubricating the moving parts.

Two basic models of the Cenco Pressovac pump are available.

Cenco No. 90500 is a vacuum and pressure pump. Cenco No. 90540 is a vacuum pump only. Since the Pressovac Vacuum Pump contains precision machined parts, a high quality, specially compounded lubricator should be used. Cenco Hyvac Oil No. 93050, provided with the pump, is specially processed and should always be used to obtain maximum performance.

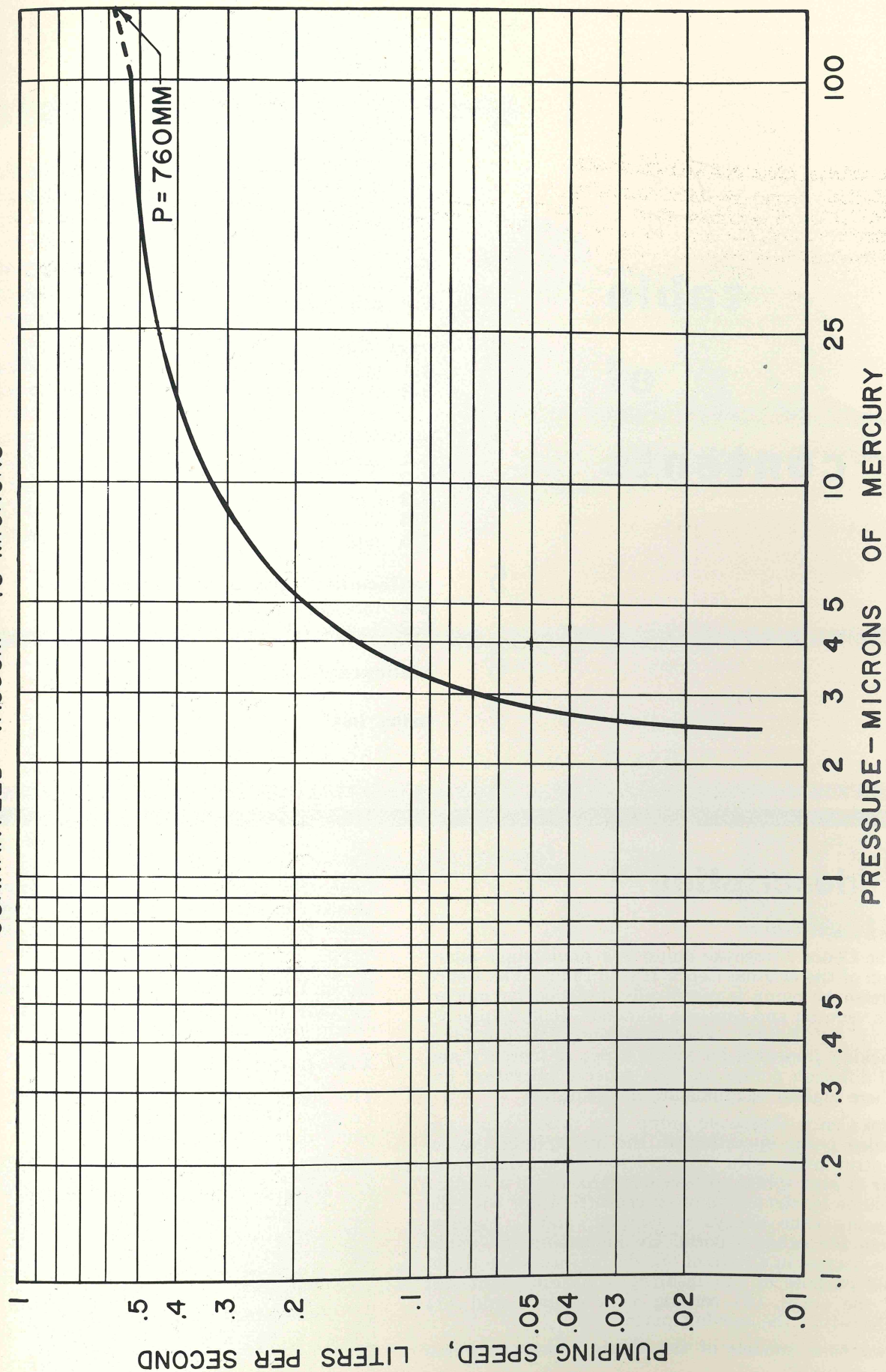
1.2 pump data

The speed pressure characteristics of the Cenco Pressovac Pump are shown in Fig. 1. Additional pump data are as follows:

Pump speed (rpm)	600
Capacity at atmospheric pressure (liter/min.)	35
Capacity at 100 microns of mercury (liter/min.)	25
Maximum operating pressure (psig)	10
Guaranteed vacuum (microns of mercury)	
without pump plate	15
with pump plate	25

SPEED-PRESSURE CURVE CENCO PRESSOVAC PUMP

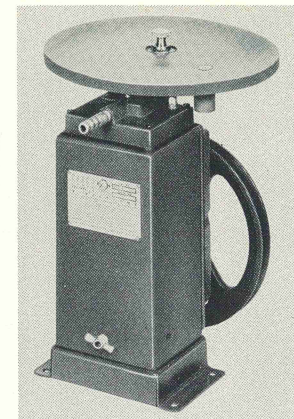
GUARANTEED VACUUM = 15 MICRONS



1.3 unmounted pump



CENCO NO. 90500



CENCO NO. 90505



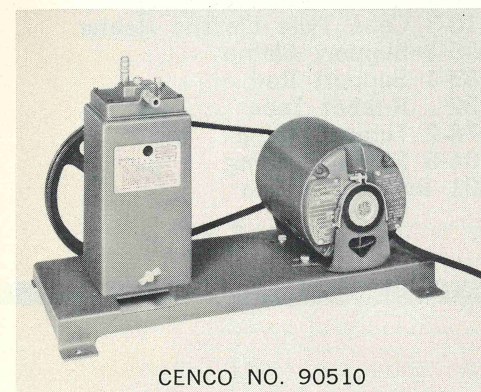
CENCO NO. 90540

Cenco No. 90500 consists of Pressovac pump mounted on sub-base and is supplied with suitable grooved pulley. This pump is suited for vacuum and pressure applications.

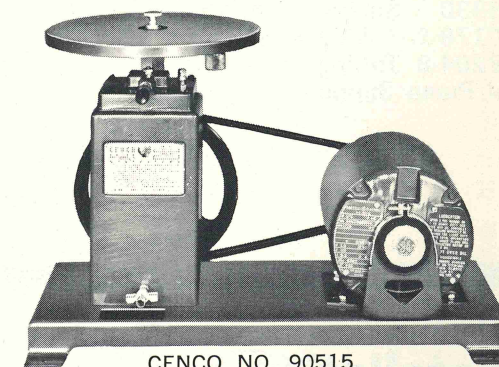
Cenco No. 90505 is the same as Cat. No. 90500 but with the addition of a pump plate, Cenco No. 90520.

Cenco No. 90540 Pressovac Pump is an unmounted pump for vacuum applications only. This pump is supplied with a sub-base and a grooved pulley.

1.4 pump mounted with motor



CENCO NO. 90510



CENCO NO. 90515

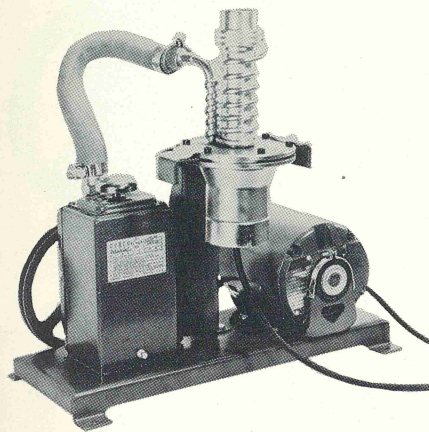
A wide selection of mounted pump assemblies is available. The mounted Pressovac pump is as-

sembled on a steel base and is supplied with motor and a belt drive.

Cenco No. 90540 Vacuum only	Cenco No. 90500 Vacuum and Pressure			MOTOR RATING
	Without pump plate	With pump plate Cenco No. 90520	With pump plate Cenco No. 90521	
90550-1 90550-2	90510-1 90510-2	90515-1 90515-2	90516-1 —	115 V., 60 cycle, 1 phase 230 V., 60 cycle, 1 phase
— —	90510-3 90510-4	90515-3 90515-4	— —	115 V., DC 230 V., DC
— —	— 90510-7	90515-5 90515-7	— —	115 V., 25 cycle, 1 phase 115 V., 50 cycle, 1 phase
— —	90510-8 90510-10	90515-8 —	— —	230 V., 50 cycle, 1 phase 115 V., 60 cycle, 1 phase Explosion Proof
—	90510-23	—	—	No motor

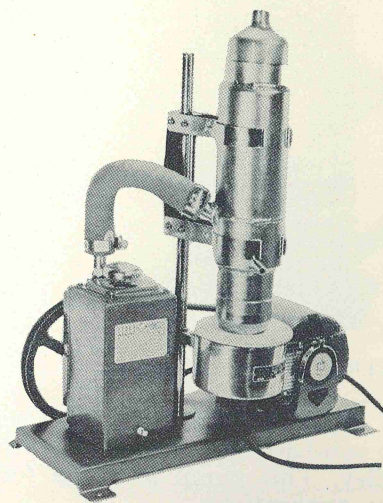
1.5 high vacuum pump outfits

Two complete High Vacuum Pump Outfits are available.



Cenco No. 93275-1 Oil Diffusion Pump Outfit consists of:

- No. 90550-1 Cenco Pressovac Pump
- No. 93330 Supervac OD-25
- No. 12178-2 Tubing Clamp
- No. 18204-8 Tubing
- Special Pump Support



Cenco No. 93265-1 Mercury Diffusion Pump Outfit consists of:

- No. 90550-1 Cenco Pressovac Pump
- No. 93210-3 Cone Type Electric Heater
- No. 93205-2 Support Clamp
- No. 72185-1 Support Rod
- No. 94222 Rubber Tape
- No. 12178-2 Tubing Clamp
- No. 18204-8 Rubber Tubing
- No. 93201 Diffusion Pump

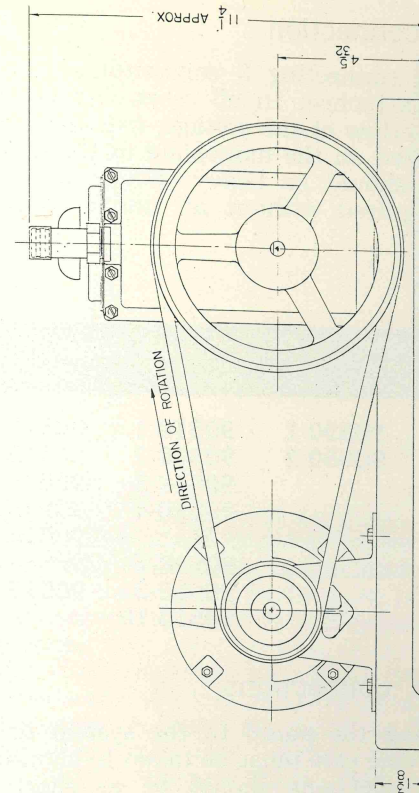
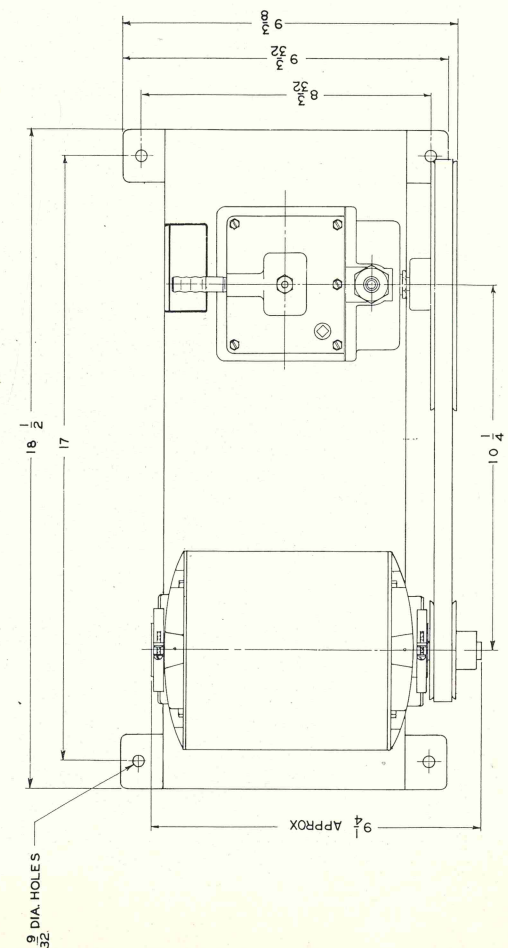
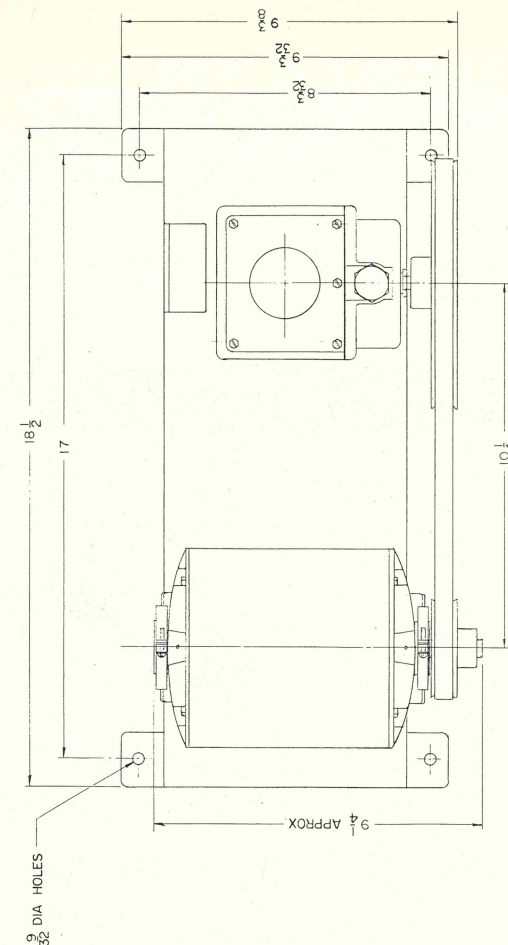
2 installation

2.1 mounting

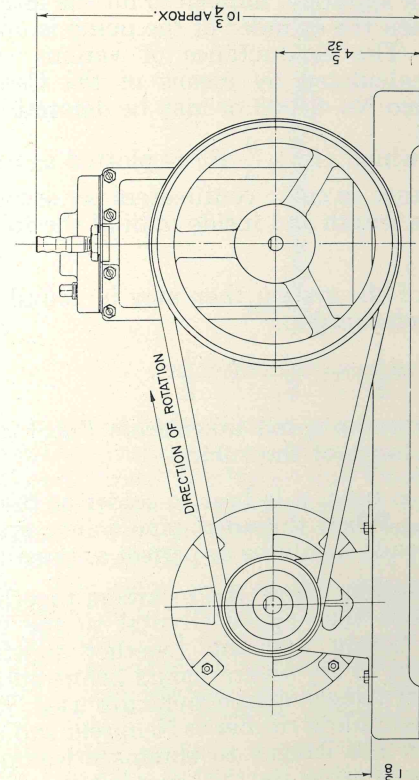
If the mounted pump is obtained, the pump is immediately ready for use.

If an unmounted pump is obtained, the pump should be mounted on a flat, rigid, steel or cast-iron base, such as supplied with the mounted unit as shown in Fig. 2. Provisions should be made for bolting the base to the floor or, if used in a movable unit, to the frame. When electronic equipment is attached to the same frame Shock mounts should be obtained so that vibrations from the motor or pump will not be transmitted through the frame. The sub-bases are provided with four mounting holes $\frac{1}{4}$ " diameter on $5\frac{1}{2}$ " and $2\frac{15}{16}$ " centers.

A belt drive connects the motor with the pump. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump. The pump may be driven at any speed up to 600 RPM. Variations in speed will normally affect only the volumetric speed of the pump. The major dimensions of the pump, pump base and motor are given in Fig. 2.



90550



90510

Fig. 2, Outline of Pressovac Pump

2.2 motor connection

Motors have a connecting 3 conductor grounded cord and plug attached. In all cases, connect the motor to a powerline of the voltage, frequency and phase as indicated on the nameplate of the motor. The powerline should be heavy enough to carry the current required without an undue drop in voltage.

Cenco Pump No.				Current at full Max. fuse rating load (amperes) (amperes)	
90550-1	90510-1	90515-1	90516-1	5.6	20
90550-2	90510-2	90515-2		2.8	15
	90510-3	90515-3		2.5	15
	90510-4	90515-4		1.3	15
		90515-5		4.0	15
	90510-7	90515-7		5.4	15
	90510-8	90515-8		2.7	15
	90510-10			4.2	15

2.3 vacuum connections

When connecting the pump to the system to be evacuated, extreme care must be taken to eliminate leakage. All connections should be as short as possible, and of large diameter to reduce molecular friction. When the pump is operating in the low micron range, the flow of gas through a tube is substantially molecular in character. At low pressures, the gas removed from the system is confined largely to those molecules which, because of their kinetic energy of agitation, happen to hit the intake of the pump when the cylinder of the pump is open to the intake. The conductance of various size tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008 or may be determined

from Fig 3, in which $(L + \frac{8}{3} R)$ is plotted against Z, the conductance in cubic centimeters per second. L and R are the length and inside radii of the tubes in centimeters.

The net speed of the system then may be found by the following relationship:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pump speed taken from Fig. 1 and Z is the conductance of the tubing.

If metal piping is used, it is best to solder or braze all connections. When threaded pipe joints must be used, the threads should be as perfect as possible.

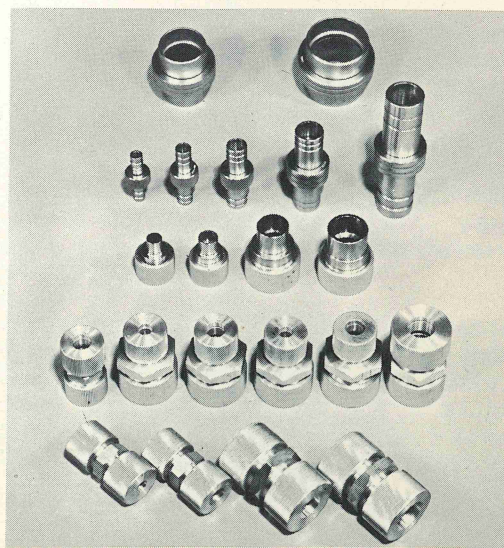
In such a connection, screw the members together several turns, and then apply Glyptal to the exposed threads before screwing together tightly. Allow the Glyptal to dry several hours before starting the pump. If flanged connections are used, flat or O-ring gaskets made of rubber or Neoprene should be used between the flanges to eliminate leakage. Place a thin coat of oil on the "O" ring before using. Cenco manufactures an extensive line of couplings,

All motors may be operated on "across the line" start. Remember that fuses provide short-circuit protection only for the power supply line and do not protect the motor from overload. It is recommended that a suitable starting switch with motor overload protection be used for all permanent installations.

For correct selection of the fuse, consult the list below:

connectors and accessories for use in high vacuum systems (see Cenco Booklet 327). Some of these are:

Cenco No.	Name	For Tubing	Size Range
94226	straight through	glass and/or metal	$\frac{3}{8}$ " - 1"
94235	straight through	metal and/or rubber	$\frac{1}{4}$ " - 2"
94228	reducing	glass and/or metal	$\frac{3}{8}$ " - 1"
94230	connectors	metal-to-glass	$\frac{3}{8}$ " - 1"
94240	caps	for 94235	$\frac{1}{4}$ " - 2"
94245	nipples	rubber	$\frac{3}{8}$ " - $1\frac{3}{16}$ "



Typical Cenco Vacuum Connectors

The Pressovac pump is provided with a one-piece intake nipple. As supplied, the nipple is intended primarily for use with rubber tubing. When glass connections are used between the pump intake nipple and the system, it is recommended to use a short rubber hose as a coupling between nipple and glass tube.

When tapered glass joints or ball joints are used in connections, a vacuum stopcock grease (No. 15517-1 or No. 15522) should be applied to both members.

Rubber tubing connections should be kept as short as possible and made with an extra heavy wall, gum tubing, such as No. 18204, which has been compounded specially for vacuum work. All connections to metal or glass tubing should fit snugly and both members should be coated with vacuum stopcock grease.

The Pressovac is also a pressure pump equipped with a pressure safety valve mounted on the top of the pump case. The maximum operating pressure is 10 p.s.i. and care should be taken not to exceed this value.

Pressure connections are made to the outlet nipple extending to the side, while the vacuum connections are made to the inlet nipple extending upward, or to the opening at the center of the pump plate. The pump cannot be used for vacuum and pressure at the same time.

A bypass connection should be used between the pump and the apparatus when the pump is operating for pressure. This bypass may consist of a T-shape connecting tube, Cenco No. 15650, with a short length of rubber tubing and pinch clamp on the open end. With the pinch clamp, adjust the bypass so that the pump may deliver air to the device at the minimum pressure required for the device's operation. In no case should the bypass clamp be closed so as to produce a continual operation of the safety valve. When the pump is operated at such a pressure which is in excess of its rated value, an excess vaporization of the oil occurs.

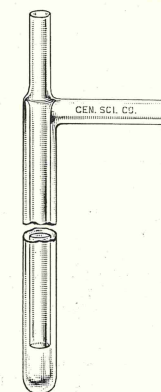
If the oil vapor produced by the pump at or near the limiting pressures is objectionable, it may be removed by passing the air through a filter flask or similar device containing glass wool. Cat. No. 93975 Koby air purifier is suggested for this purpose.

2.4 valves

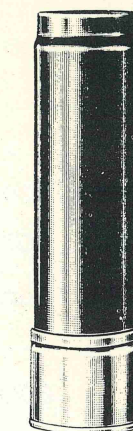
Metal vacuum valves and glass stopcocks are employed generally in the connecting line between the pump and the system to provide a means of connecting the vacuum gage and for vacuum release when stopping the pumping. When metal pipes are used for the line, a high-vacuum valve such as No. 94551 is recommended.

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of testing the pump and system for leaks by the "pressure rise" method without disconnecting the pump from the line.

2.5 traps



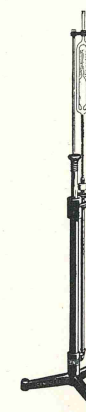
No. 94005 liquid air trap



No. 15830-3 Dewar flask

Extreme care must be taken to prevent solid particles from reaching the intake of the pump. They will score the working parts of the pump and reduce its efficiency. If corrosive vapors are in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor from the pump from entering the system. A Cenco No. 94005 or No. 94006 Glass Trap is recommended. Either should be used in a No. 15830-3 Vacuum Flask. The refrigerant most commonly used in the vacuum flask is a mixture of solid carbon dioxide (dry ice) and acetone or ethyl alcohol.

2.6 gages



No. 94151 McLeod gage

The types of high vacuum gages commonly used in a system employing a Pressovac pump are the McLeod, Pirani, Discharge, and Thermocouple gage. A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 mm Hg to 1.6 mm Hg (0.5 microns Hg to 1600 microns Hg). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint. The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 microns and from 1 to 50 microns of mercury. The Thermocouple gage permits measurements in the range from 1 to 1000 microns of mercury. The Discharge gage operates within the range of 0.001 to 20 microns of mercury.

CONDUCTANCE OF TUBES FOR AIR AT 20°C

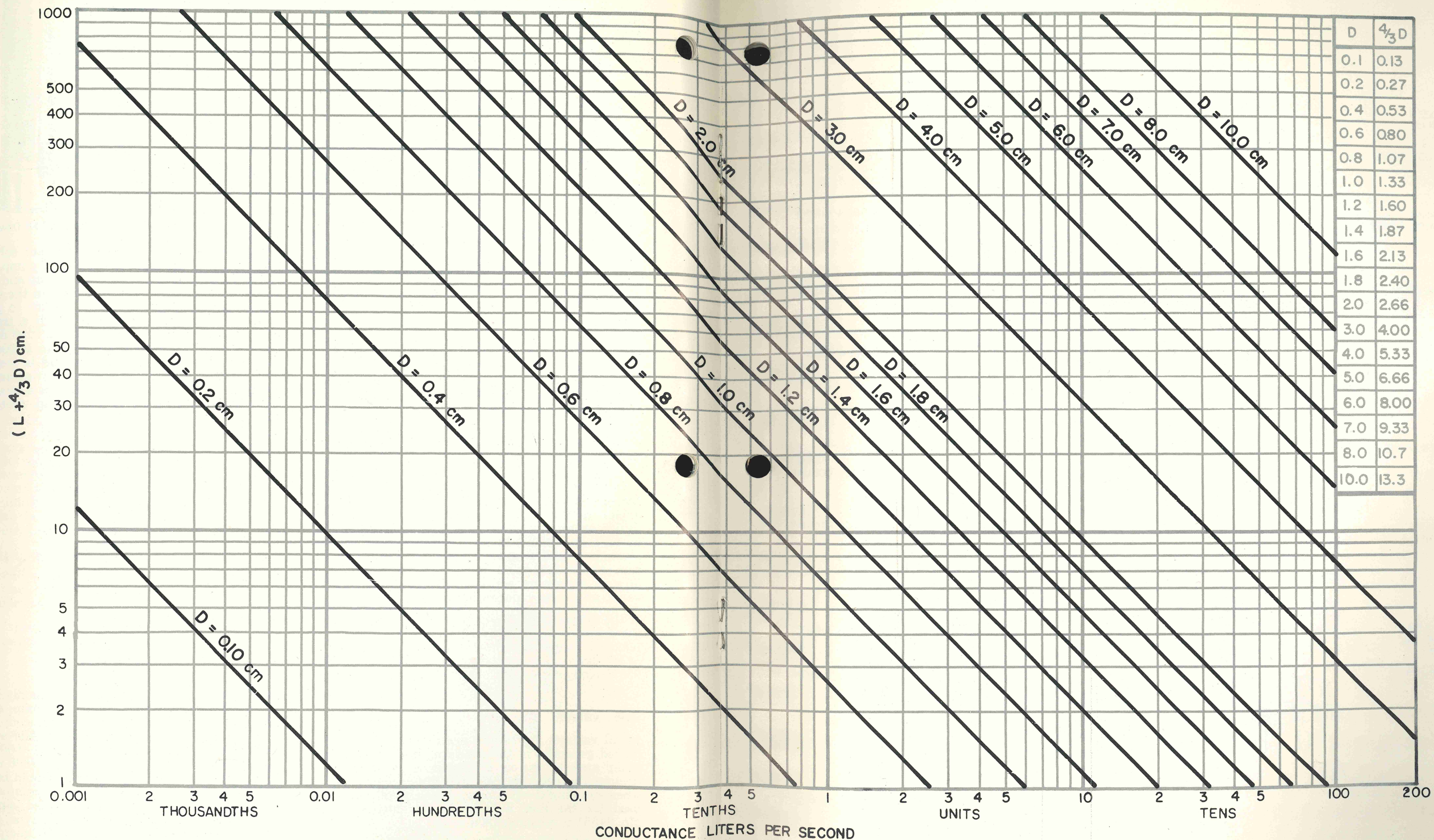


Fig. 3.

TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain pumping speed (S) as large as possible, the tube conductance (Z) must be very large as compared with the speed of the pump (S_1), as is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} \cdot S_1$$

Since at best (S) is only a fraction of (S_1), the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance, (Z), shown in litres/sec, is plotted as abscissas against the quantity ($L + 4/3 D$), in cm., as ordinates. In addition to the parameter D, the value of $4/3 D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the value of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm. long having a diameter of 2 cm. is required. From the table, for D=2, it is seen the $4/3 D = 2.66$ cm. Referring to the curve, for D=2 the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $4/3$ the diameter) is about 1750 cc/sec.

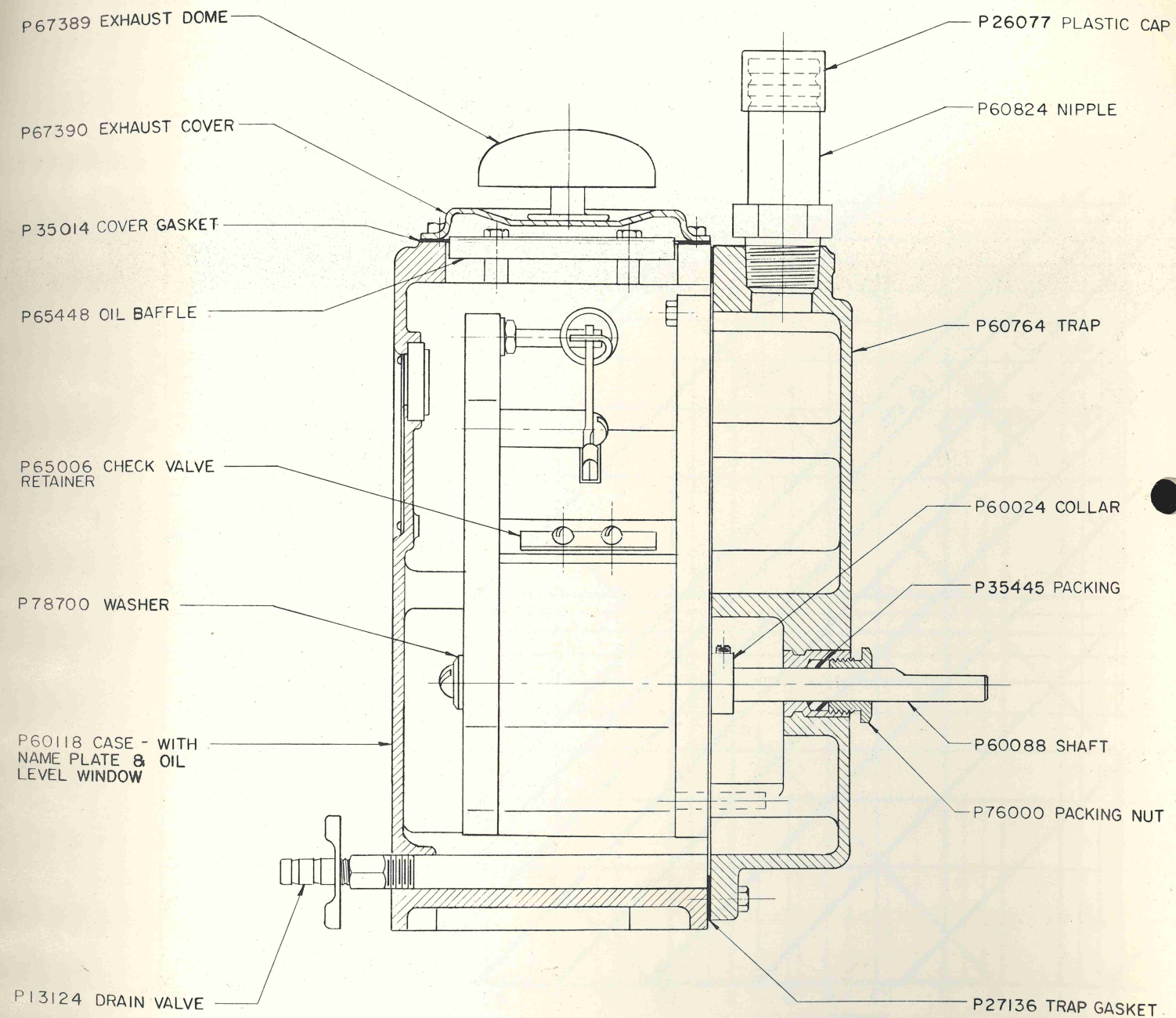
Since the curves are parallel lines, spaced logarithmically, conductance of tubes having other diameters than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely

$$\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$$

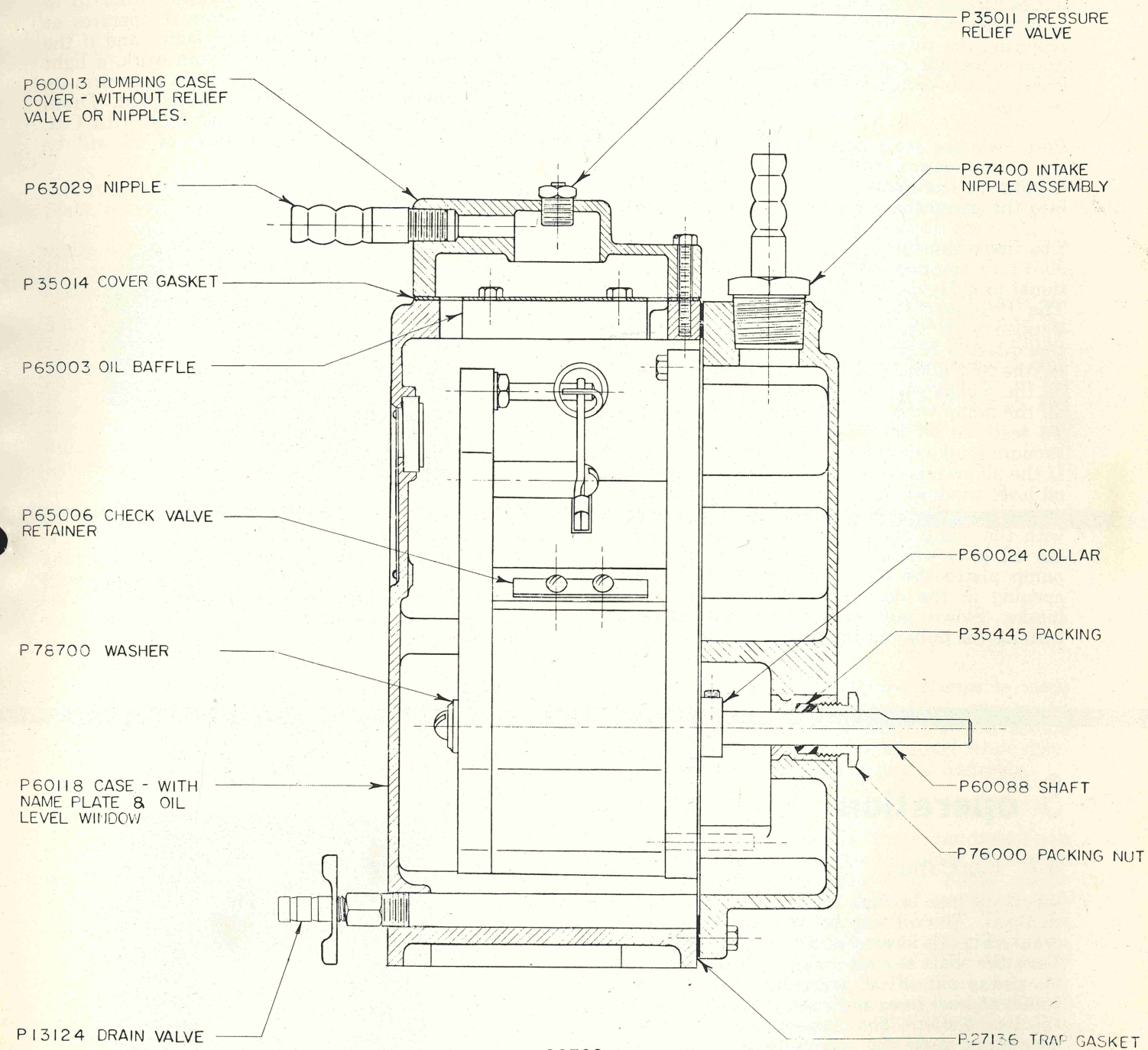
where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.



90540

Fig. 4, Sectional View



90500

Fig. 4, Sectional View

2.7 oil and drain valve

The oil drain valve on the Pressovac pump is removed during shipment in order to prevent damage. When installing the pump remove the pipe plug and replace by means of the separately supplied drain valve. Before removing the pipe plug make sure that the plastic caps close the intake and outlet nipples of all pumps containing oil in order to prevent the oil from leaving the reservoir. When replacing the valve itself tilt the pump so that the drain valve side is raised. No precautions are necessary if the pumps do not contain oil inside the reservoir.

Best leak-free seals between the drain valve and the pump casing will be obtained by applying Glyptal to the drain valve thread before screwing into the pump housing.

The Pressovac Pump No. 90500, 90505, 90510 and 90515 are shipped with oil in the pump. One additional pint Hyvac Oil is supplied with each pump. The Pressovac Pump No. 90540 and 90550 are shipped with the oil drained from the reservoir. One quart of Hyvac Oil is supplied with each pump for the first filling and for periodic oil changes. To fill the pumps with oil, first unscrew the dome and fill the pump with oil up to the oil level sight gage. To test the oil level operate the pump with the vacuum intake closed and the dome screw removed. If the oil level is correct, oil will be observed at the oil level window. If oil is needed, remove the plug on one side of the top and slowly pour in oil until, with the pump operating, it reaches the center of the oil level window. To add oil to pumps with pump plates the oil must be added through the opening in the center of the plate, the vacuum intake. Slowly pour the oil into the intake while turning the pulley in the proper direction by hand.

3 operation

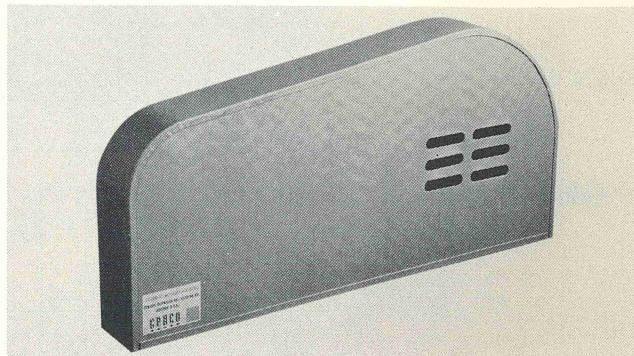
3.1 lubrication

When oil has become contaminated it should be changed. The oil may be removed by opening the drain (Fig. 4) located at the front of the housing. Turn the shaft several revolutions to force out any remaining oil. Flush with clean flushing oil No. 93060 at least once and then refill with new Hyvac Oil No. 93050. The frequency of oil change is dependent upon the service of the pump. An oil change may be needed only once in six months or longer if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosion and easily condensable vapors enter the pump. On continuous duty the oil temperature may reach 50° to 60° C. This is normal for efficient operation of the pump.

The correct oil level is established when with the pump operating with closed intake, the oil level should be visible just above the horizontal line of the oil level window.

All Pressovacs are supplied with heavy pump oil, Cat. No. 93055, as this oil has been found most satisfactory for both vacuum and pressure work. With this heavy oil the pump requires from 10 to 15 minutes warm-up period before it operates at maximum efficiency. If time is a factor and if the pump is to be used only for vacuum work, a light grade oil, Cat. No. 93050, will reduce the warm-up period greatly and its use is recommended. Drain the heavy oil from the pump and refill with Cat. No. 93050 Hyvac Oil. One quart of oil will be sufficient.

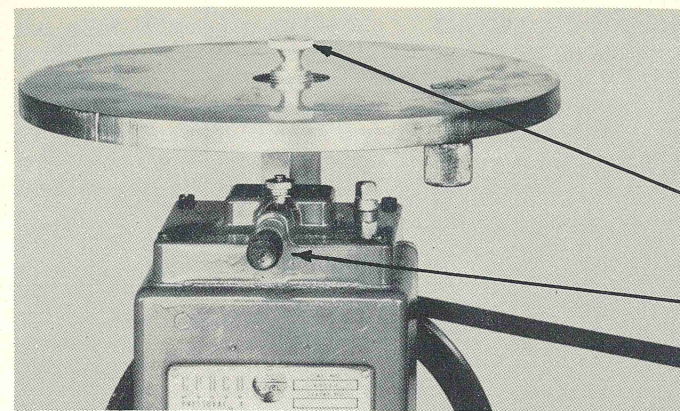
2.8 belt guard



A well designed guard is a desirable protection against personnel hazards, and also protects the pump from damage caused by objects becoming entangled in the belt or pulley. Cenco pump bases are drilled to receive the guards, and each guard is sold ready for mounting. The order number for this belt guard is given in Paragraph 5.2.



3.2 pump plates



Before operating pumps equipped with a pump plate, remove the solid guard plug from the center of the pump plate and insert in its place the specially drilled guard plug supplied with the pump. Remove also the rubber nipple covering the pressure outlet.

The bell jar should be sealed to the pump plate with Cat. No. 11455 Vacuum Wax. A special vacuum release valve beneath the pump plate provides a means of admitting air to the bell jar after it has been evacuated. A small rubber "O" ring in the knurled cap seals the valve. Hand tighten the knurled cap when evacuating the jar. To admit air, loosen the cap several turns or remove.

A threaded hose nipple which may be screwed into the opening in the center of the pump plate is also supplied. This will permit connecting the pump to other systems for evacuation without the necessity of removing the pump plate.

Cat. No. 90520 or 90521 Pump Plate with threaded adapter may be used when it is desirable to add the pump plate to either Cat. No. 90500 or 90510 Pump. This is easily done by removing the vacuum connecting nipple and inserting the adapter in its place. It is advisable to seal the joint with Cat. No. 10021 Glyptal Vacuum Sealing Compound.

4 maintenance

4.1 general

The maintenance requirements of the Cenco Pressovac Pump will vary with application. Proper lubrication is the most important factor in securing reliable performance. (See paragraph 2.7). If a pump is connected into a normal leak-free system, there should be no condition which should cause the pump to malfunction that cannot be remedied by simple adjustments. If a pump does not function properly, the cause usually can be attributed to a broken spring, a sticking vane or worn valve release and not a misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal use, therefore, where not corrosive vapors are encountered, it is reasonable to expect that there will be no decrease in the efficiency of a pump over a period of several years.

4.2 shaft seal

The stuffing-box nut on the pump shaft bearing should be tightened occasionally to take up wear in the packing, thus preventing leakage of oil at this point. New packing may be needed from time to time.

4.3 belt

The belt adjustment in mounted pumps is made by loosening the bolts in the base of the motor and moving in the required direction. The belt should be just tight enough to prevent slippage while operating. A little slippage on starting is desirable.

4.4 vane

The vane and spring in the Pressovac pump can be inspected by removing the top plate. A broken spring will prevent the vane from riding snugly against the rotor during its cycle of operation, thus causing a failure in operating efficiency. The vane may be inspected occasionally but the process must be accomplished with extreme care. The vane may be removed after the spring has been released. By turning the pump by hand, one can determine how much of the vane is protruding above the surface of the pump housing and any markings on this part of the vane will do no harm. It is our practice to pull the vane out with sharp-nosed pliers, but extreme care should be taken to see that the nose of the pliers does not extend down over the part of the surface which slips into the vane slot housing. The vane might be rather difficult to remove because it is usually under atmospheric pressure. This is true

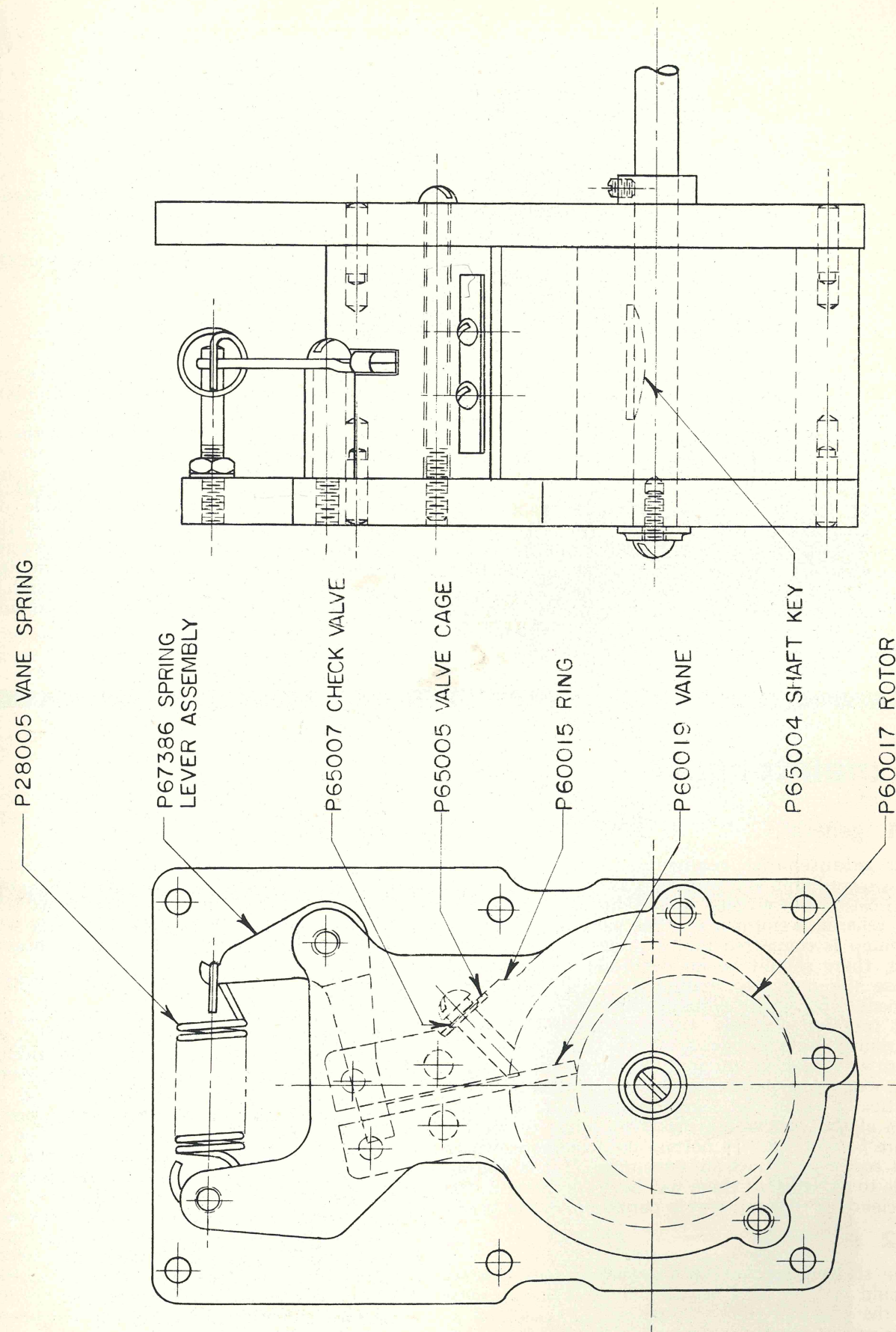


Fig. 5

particularly if the pump has been in operation just prior to the removal of the vane. There are no loose parts which will become disturbed by the removal of the vane and it can be taken out without any trouble. Any dirt or particles of grit which may be lodged around the upper part of the vane should be carefully removed before the vane is taken out since this material getting into the pump will score the stator as well as the rotor. After removing the vane, it may be polished slightly with the very finest of emery paper if it appears to be corroded. The vane is ground to an established tolerance of 0.0005 inch and, therefore, no portion of the metal should be

removed during the polishing process. As long as the pump is producing a satisfactory vacuum and no corrosion is present, it is advisable not to polish the vane.

4.5 repairs

Fig. 4 shows a cross sectional view of the Pressovac pump. Paragraph 5.1 lists most parts for the pump. When ordering replacement parts, please state the exact part number. For repairs to the pump other than the replacement of the shaft seal and where adequate shop facilities are not available, it is strongly recommended that the pump be returned to the factory.

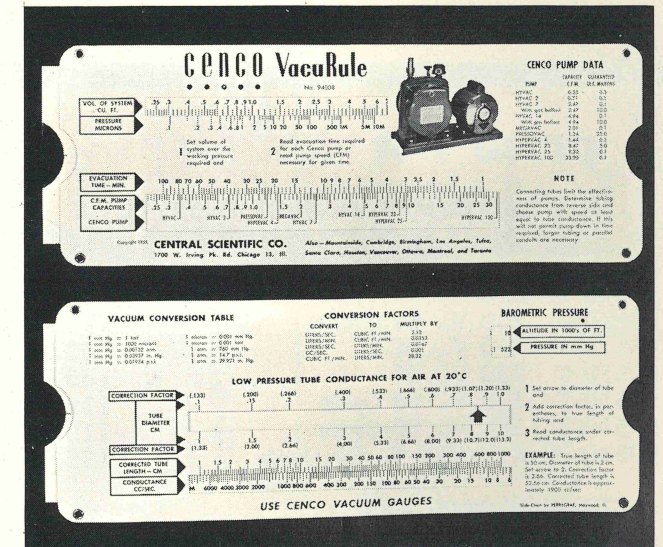
5 replacement parts and accessories

5.1 replacement parts

Part No.	Part Description	Parts per pump	Price
P60013	Pump Case Cover (Without relief valve or nipples)	1	\$ 3.50
P65003	Oil Baffle	1	0.15
P35011	Pressure Relief Valve	1	0.90
P60015	Ring ¹	1	10.00
P60017	Rotor	1	10.00
P60019	Vane ¹	1	3.75
P60088	Shaft	1	2.00
P60118	Finished Pump Case (Without Trap) (Complete with Name Plate & Drive Screws for attaching same & Oil Level Window).	1	12.50
P63029	Nipples	2	1.00
P67386	Spring Lever Assembly	1	2.00
P28005	Vane Spring	1	0.25
P35014	Cover Gasket	1	0.25
P27136	Gasket, Trap	1	0.50
P35445	Packing, Shaft Seal	1	0.30
P65004	Shaft Key	1	0.40
P76000	Shaft Packing Nut	1	0.50
P65006	Check Valve Retainer	1	0.18
P65005	Valve Cage	1	0.20
P65007	Check Valves	3	0.10
P67390	Exhaust Cover	1	2.25
P67389	Exhaust Dome	1	2.00
91131	Belt	1	2.00

5.2 accessories

BELT GUARD for enclosing the pump and motor pulleys and belts where moving parts constitute a personnel hazard. Comes ready to screw to tapped pump base.
No. 91135 Belt Guard.....\$14.75



No. 94008 Cenco VacuRule

VACU RULE, a handy slide rule for calculating low pressure conductance, system evacuation times, and typical vacuum conversion factors.
No. 94008 Vacu Rule.....\$1.00

No. 94151 McLeod Gage\$205.00

No. 93050-2 Light Pump Oil, per quart.....\$.75

No. 15830-3 Vacuum Flask	\$12.25
--------------------------------	---------

No. 94005 Liquid Air Trap\$6.50

No. 94006-1, 25 diameter, 12 mm tubes.....\$21.00

No. 84097 Adapter\$.38

No. 94178 Thermocouple Gage\$110.00

No. 94183 Discharge Gage	\$249.50
--------------------------------	----------

No. 94185 Pirani Gage	\$196.00
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6 bibliography

Scientific Company

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Scientific Foundations of Vacuum Technique, Saul

Vacuum Technique, Arnold L. Reimann (Chapman

Industrial High Vacuum, J. R. Davy (Sir Isaac
Pittman & Sons Ltd), 1951.

No. 94185 Pirani Gage	\$196.00
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price list

MOUNTED PUMPS WITHOUT PUMP PLATE

90510-1	115 V., 60 Cycle	\$103.00
90510-2	230 V., 60 Cycle	113.75
90510-3	115 V., DC	160.50
90510-4	230 V., DC	155.00
90510-7	115 V., 50 Cycle	119.00
90510-8	230 V., 50 Cycle	119.00
90510-10	115/230 V., 60 Cycle (Explosion proof)	165.50
90510-23	Without motor	82.25

MOUNTED WITHOUT PUMP PLATE VACUUM ONLY

90550-1	115 V., 60 Cycle	\$103.00
90550-2	230 V., 60 Cycle	119.00

UNMOUNTED PUMPS

90500	Pump alone	\$ 77.50
90505	With pump plate	108.50
90540	Vacuum only	82.25

MOUNTED PUMPS WITH PUMP PLATE

90515-1	115 V., 60 Cycle	\$139.75
90515-2	230 V., 60 Cycle	160.50
90515-3	115 V., DC	186.50
90515-4	230 V., DC	181.00
90515-5	115 V., 25 Cycle	171.00
90515-7	115 V., 50 Cycle	160.50
90515-8	230 V., 50 Cycle	165.50

PUMP PLATES

90520	Pump plate, 9" diam., for mounting on 90500, 90505, and 90515	\$41.00
90521	Pump plate, 10" diam. for mounting on newer models of 90500, 90505, 95010, and 90515	\$44.00

VACUUM PUMP OUTFITS

93265-1	\$222.50
93275-1	305.00

SHIP TO:		<u>Institution, Company, or Individual</u>	<u>Date of Order</u>
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Booklet 325

GENCO

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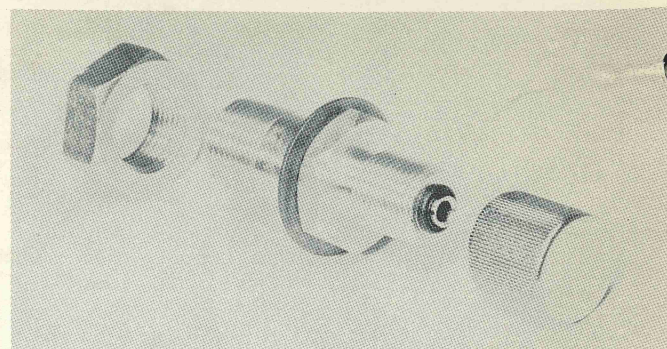
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RELEASE VALVES

No. 94270 mounts on panels up to 1/8" thick with lock nuts provided or threads into a 5/8 - 18 thread hole in pump plate of any thickness. Nipple designed for welding, brazing or soldering into standard metal tubing. No. 94270..... \$8.50

No. 94271 mounts through pump plate or system boss up to 3/4" thick. Machined of aluminum alloy and provided with "O" ring seals. No. 94271..... \$ *

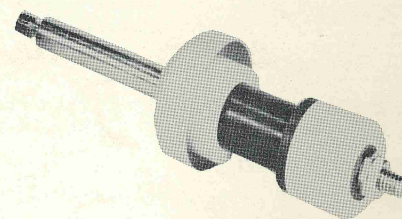
For conveniently admitting air or gases into a bell jar without disturbing pumping operations.



94271

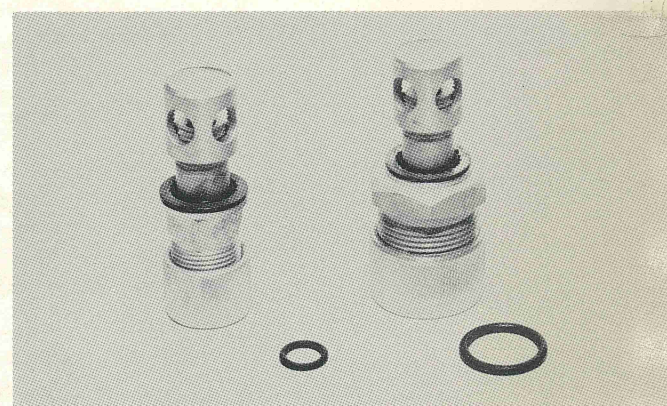
FEED-THROUGH ELECTRODES

For conducting high voltages through 3/4" thick pump plate without leakage or arc-over. Nickel-plated 3/8" diameter rod protrudes 2-3/8" above protection cup and is threaded externally and internally for mounting various clamps, etc. inside bell jar. No. 94207 with insulating grommets and nuts..... \$8.50



94207

Designed for making vacuum readings or introducing external gases without interfering operation inside bell jar.



94231

94232

GAGE PORTS

No. 94231 fits 3/4" diameter hole in pump plate or system boss and couples to 1/2" diameter gage or other glass tubing. Machined of aluminum alloy with "O" ring seal and washer. No. 94231... \$14.25

No. 94232, same as No. 94231 but couples to 1" diameter glass (or metal) tubing. For use with No. 94183 Discharge Gage. No. 94232..... \$15.00

No. 94177 Adapter for No. 94178 Thermocouple Gage, 1/8" pipe thread to No. 94231 Gage Port. No. 94177..... \$1.00

*Price to be announced.

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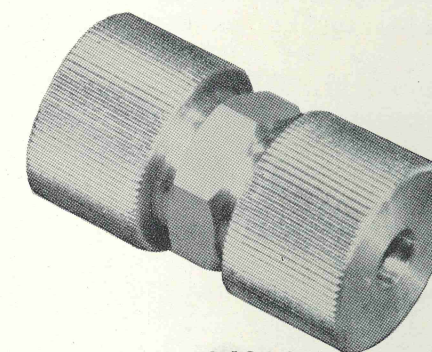
GAGE PORTS

RELEASE VALVES

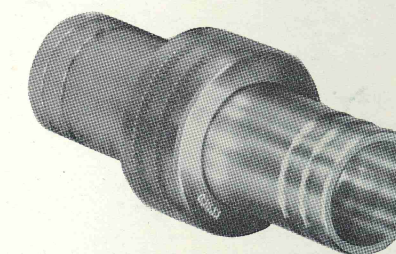
CAPS & NIPPLES

REDUCERS

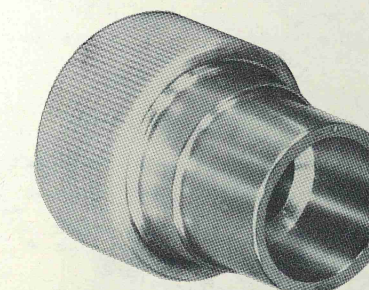
BOOKLET 327



94226



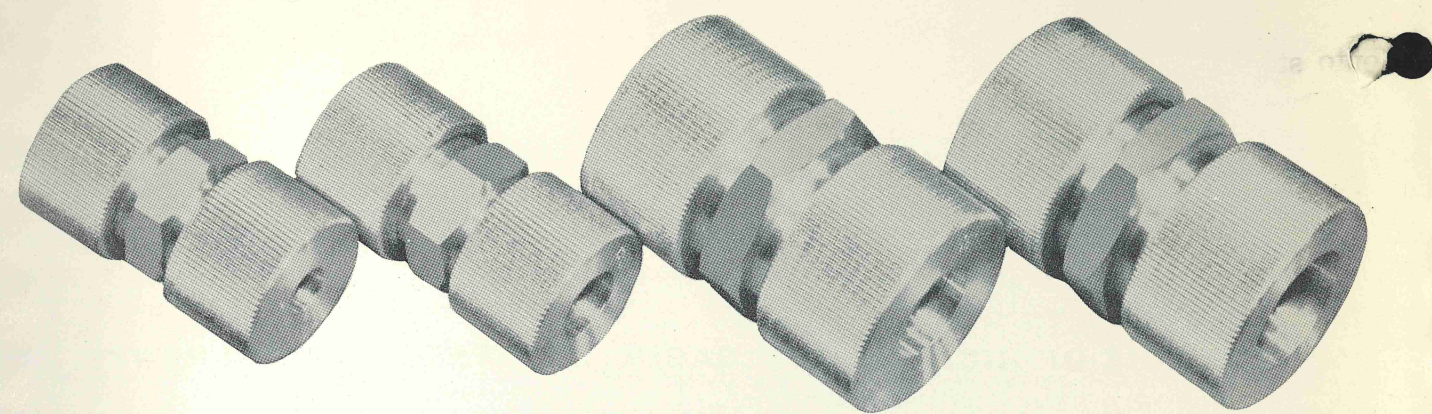
94235



94230

STRAIGHT-THROUGH COUPLINGS

glass and/ or metal tubing

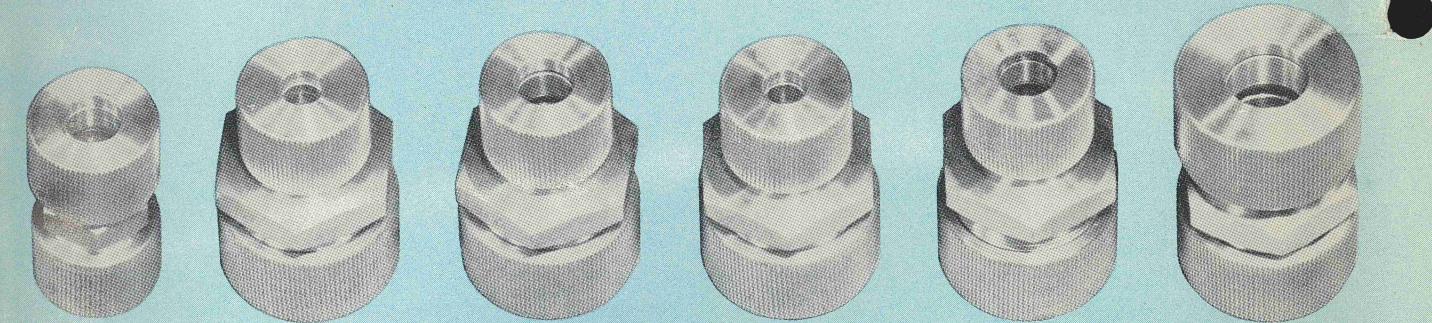


For connecting standard diameter glass and/or metal tubing in high vacuum systems where quick, easy assembly is an advantage. Eliminates unnecessary brazing and glass working. Especially useful for connecting vacuum gages into system. Machined of aluminum alloy and fitted with "O" ring seals.

CENCO NO.	COUPLING	EACH
94226-1	3/8" to 3/8"	\$6.95
94226-2	1/2" to 1/2"	6.95
94226-3	3/4" to 3/4"	10.95
94226-4	1" to 1"	11.95

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These aluminum alloy reducers solve the problem of connecting standard glass and/or metal tubing of different diameters. Rapid coupling and decoupling facilitated by large knurled nuts and "O" ring construction.

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94228-1	1/2" to 3/8"	\$6.95
94228-2	3/4" to 3/8"	8.95
94228-3	3/4" to 1/2"	9.95
94228-4	1" to 3/8"	9.95
94228-5	1" to 1/2"	9.95
94228-6	1" to 3/4"	11.95

CAPS

Used with equivalent sizes of No. 94235 straight-through couplings (metal and/or rubber) and No. 94236 "O" rings for blanking off conducting tubes in vacuum systems.

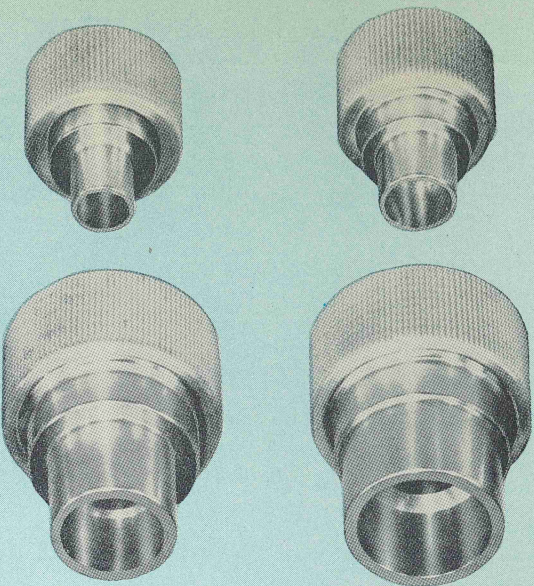
CENCO NO.	TUBING OD	EACH
94240-1	1/4"	\$1.85
94240-2	3/8"	2.00
94240-3	1/2"	2.00
94240-4	3/4"	1.85
94240-5	1"	2.10
94240-6	1-1/2"	4.50
94240-7	2"	5.00

CONNECTORS

metal to glass tubing

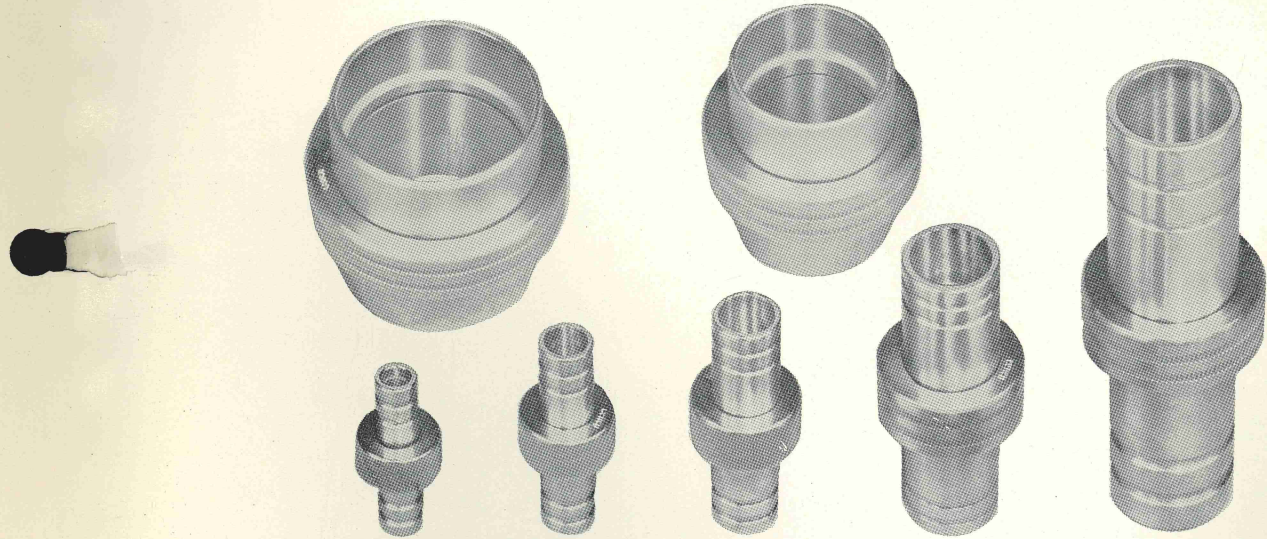
One end to be brazed, welded or soldered into standard diameter metal tubing. Glass or metal tubing may then be quickly coupled in with a knurled nut and "O" ring to make a vacuum tight connection. Ideal for permanent gage ports. Body nickel-plated brass with aluminum alloy knurled nut and compression collar.

CENCO NO.	CONNECTOR	EACH
94230-1	3/8" to 3/8"	\$4.95
94230-2	1/2" to 1/2"	5.95
94230-3	3/4" to 3/4"	6.95
94230-4	1" to 1"	7.95



STRAIGHT-THROUGH COUPLINGS

metal and/ or rubber tubing



For connecting standard diameter metal and/or vacuum rubber tubing such as No. 18204 into a system where quick, convenient coupling is required. Dual purpose nipple counter-bored to take standard metal tubing and is serrated to grip rubber tubing. Sizes 6 and 7 for metal tubing only.

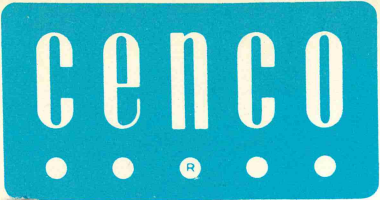
CENCO NO.	COUPLING	EACH
94235-1	1/4" to 1/4"	\$4.25
94235-2	3/8" to 3/8"	4.50
94235-3	1/2" to 1/2"	5.25
94235-4	3/4" to 3/4"	7.50
94235-5	1" to 1"	13.50
94235-6	1-1/2" to 1-1/2"	18.50
94235-7	2" to 2"	19.50

NIPPLES

Replacement part of No. 94235 straight-through coupling (metal and/or rubber) and for use with Cenco high vacuum tubing such as No. 18204. Two serrations assure firm grip on rubber tubing.

CENCO NO.	Metal Tube OD	Rubber Tube BORE	EACH
94245-1	3/8"	1/4"	\$1.10
94245-2	1/2"	7/16"	1.30
94245-3	5/8"	7/16"-5/8"	1.75
94245-4	29/32"	13/16"	3.00
94245-5	1-3/16"	13/16"	6.25

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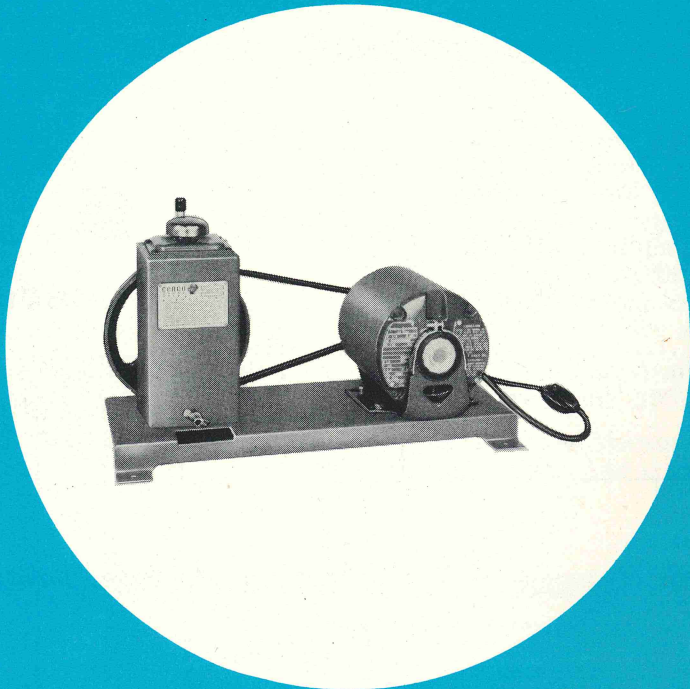


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mechanical vacuum pumps

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A two-stage, oil sealed mechanical pump of the internal moving vane design for pumping down to 0.3 microns of vacuum with moderate speed. Its reasonable cost and size make this dependable pump ideal for research and educational laboratory applications. It has also found wide acceptance in the chemical process industry where a continuous high vacuum is required.

\$119.00

	GUARANTEED VACUUM (microns of mercury)	CAPACITY		BOOKLET
		at atmosphere (liters per min.)	at 1 micron (liters per min.)	
Hyvac	0.3	10	5	320
Hyvac 2	0.1	20	9	321
Hyvac 7	0.1	70	30	
Hyvac 14	0.1	140	60	
Hyvac S14	10.0	140	—	322
Megavac	0.1	57	22	323
Hypervac 23	5.0	240	—	324
Hypervac 25	0.1	264	120	
Hypervac 100	0.1	960	660	
Pressovac 93033	25.0	35	—	325
Blower Pump	3 IN. Hg	35	—	326



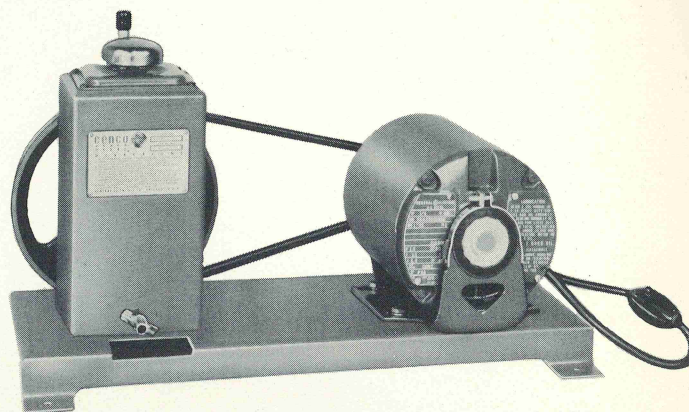
HYVAC

CENCO HYVAC PUMP

Booklet 320 operation and maintenance instructions

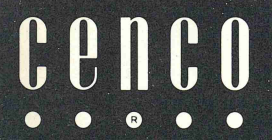
A two-stage, oil sealed mechanical pump of the internal moving vane design for pumping down to 0.3 microns of vacuum with moderate speed. Its reasonable cost and size make this dependable pump ideal for research and educational laboratory applications. It has also found wide acceptance in the chemical process industry where a continuous high vacuum is required.

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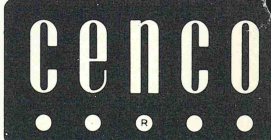
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1 description

1.1 general

The Cenco Hyvac pump is a rotary type, oil-sealed pump operating on the principle of the eccentric rotor with spring-actuated moving vane. Air at atmospheric pressure is forced into a smaller volume by the action of an eccentric rotor with moving vane always in contact, and is expelled from the exhaust ports.

The Hyvac is a two-stage, series connected pump. The two stages, intake and exhaust, have equal volumetric displacement. Two springs are used to actuate the two vanes, one spring for each vane. By immersing the entire mechanism in a bath of oil, the oil serves the three fold purpose of insuring a vacuum tight seal of the stages, serving as a coolant, and lubricating the moving parts.

Since the Hyvac Vacuum Pump contains precision machined parts, a high quality, specially compounded oil should be used. Cenco Hyvac Oil No. 93050, provided with the pump, is specially processed and should always be used to obtain maximum performance.

1.2 pump data

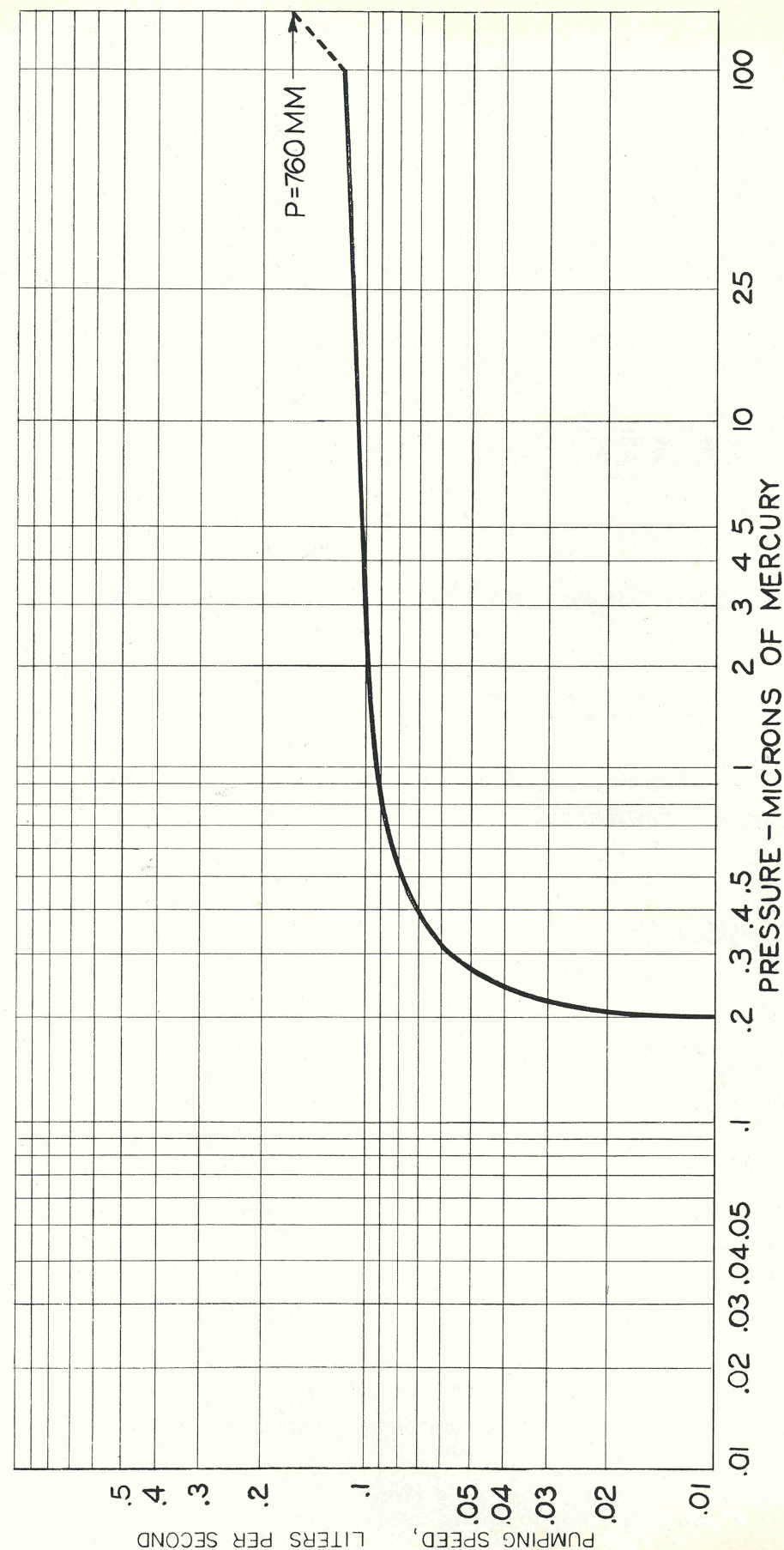
The speed pressure characteristics of the Cenco Hyvac Pump are shown in Fig. 1. Additional pump data are as follows:

Pump speed (rpm)	350
Capacity at atmospheric pressure (liter/min.)	10
Capacity at 1 micron of mercury (liter/min.)	4.6
Guaranteed vacuum (microns of mercury)	0.3
Merit Factor (%) ¹	46

1.3 unmounted pump

The Hyvac Pump, Cenco No. 91100, is supplied with a grooved pulley only. Four mounting holes, 1/4" diameter on 5 1/2" and 2 13/16" centers are provided on the bottom of the pump subbase.

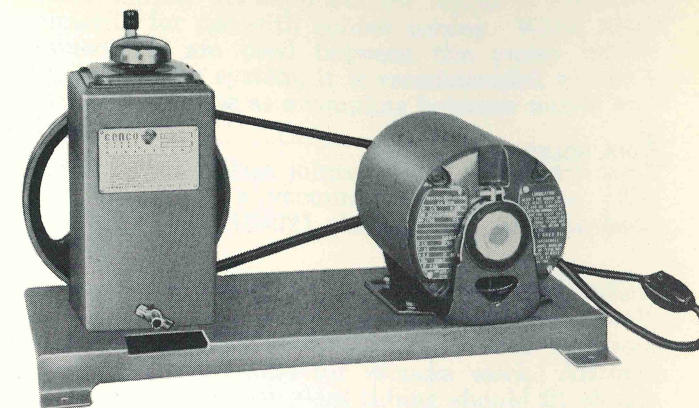
¹ The merit factor is the ratio of the pumping speed at one micron to the pumping speed at atmospheric pressure.



1.4 pump, mounted with motor

The Hyvac Pump, Cenco No. 91105, is assembled on a steel base and supplied with motor and a belt drive.

Cenco Cat. No.	Motor Rating
91105-1	115 V, 60 cycle, 1 phase, 1/4 hp.
91105-2	230 V, 60 cycle, 1 phase, 1/4 hp.
91105-3	115 V, DC, 1/4 hp.
91105-4	230 V, DC, 1/4 hp.
91105-5	115 V, 25 cycle, 1 phase, 1/4 hp.
91105-7	115 V, 50 cycle, 1 phase, 1/4 hp.
91105-8	230 V, 50 cycle, 1 phase, 1/4 hp.
91105-10	115 V, 60 cycle, 1 phase, 1/4 hp. Explosion proof
91105-23	No motor supplied, otherwise same



2 installation

2.1 mounting

If the mounted pump is obtained, the pump is immediately ready for use.

If an unmounted pump is obtained, the pump should be mounted on a flat, rigid, steel or cast-iron base, such as supplied with the mounted unit as shown in Fig. 2. Provisions should be made for bolting the base to the floor or, if used in a movable unit, to the frame. When electronic equipment is attached to the same frame Shock mounts should be obtained so that vibrations from the motor or pump will not be transmitted through the frame.

A belt drive connects the motor with the pump. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump. The best operating speed is 350 rpm, although a variation in speed between 300 and 600 rpm will only change the volumetric speed of the pump. The major dimensions of the pump, pump base and motor are given in Fig. 2.

2.2 motor connection

Motors have a connecting 3 conductor grounded cord and plug attached (except Cenco Nos. 91105-10 and 91105-23). In all cases, connect the motor to a powerline of the voltage frequency and phase as indicated on the nameplate of the motor. The powerline should be heavy enough to carry the current required without an undue drop in voltage. All motors may be operated on "across the line" start. Remember that fuses provide short circuit protection only for the power supply line and do not protect the motor from overload. It is recommended that a suitable starting switch with motor overload protection be used for all permanent installations.

For correct selection of the fuse, consult the list below:

Cenco Pump No.	Current at full load (amperes)	Max. fuse rating (amperes)
91105-1	5.6	20
91105-2	2.8	15
91105-3	2.5	15
91105-4	1.3	15
91105-5	4.0	15
91105-7	5.4	15
91105-8	2.7	15
91105-10	4.2	15

2.3 vacuum connections

When connecting the pump to the system to be evacuated, extreme care must be taken to eliminate leakage. All connections should be as short as possible, and of large diameter to reduce molecular friction. When the pump is operating in the low micron range, the flow of gas through a tube is substantially molecular in character. At low pressures, the gas removed from the system is confined largely to those molecules which, because of their kinetic energy of agitation, happen to hit the intake of the pump when the cylinder of the pump is open to the intake. The conductance of various size tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008 or may be determined from Fig. 3, in which $(L + \frac{4}{3}D)$ is plotted against Z, the conductance in cubic centimeters per second. L and D are the length and inside diameter of the tubes in centimeters.

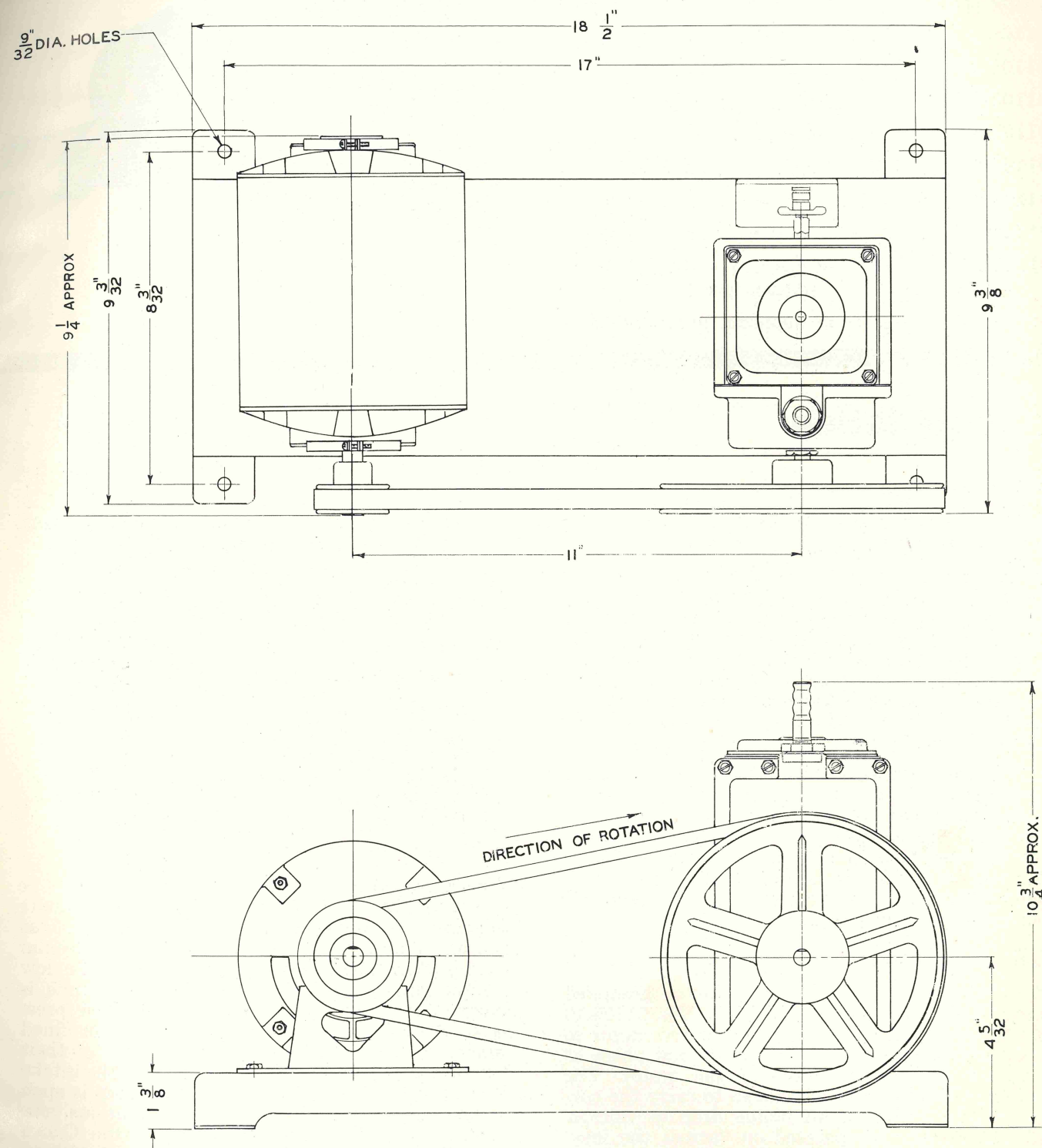


Fig. 2, Outline Hyvac Pump

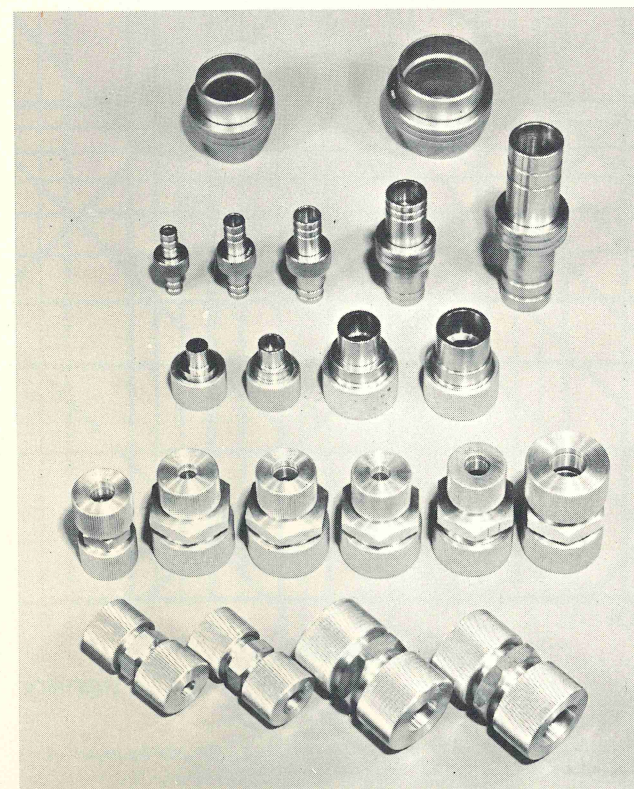
The net speed of the system then may be found by the following relationship:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pump speed taken from Fig. 1 and Z is the conductance of the tubing.

If metal piping is used, it is best to solder or braze all connections. When threaded pipe joints must be used, the threads should be as perfect as possible. In such a connection, screw the members together several turns, and then apply Glyptal to the exposed threads before screwing together tightly. Allow the Glyptal to dry several hours before starting the pump. If flanged connections are used, flat or O-ring gaskets made of rubber or Neoprene should be used between the flanges to eliminate leakage. Place a thin coat of oil on the "O" ring before using. Cenco manufactures an extensive line of couplings, connectors and accessories for use in high vacuum systems (see Cenco Booklet 327). Some of these are:

Cenco No.	Name	For Tubing	Size Range
94226	straight through	glass and/or metal	3/8" - 1"
94235	straight through	metal and/or rubber	1/4" - 2"
94228	reducing	glass and/or metal	3/8" - 1"
94230	connectors	metal-to-glass	3/8" - 1"
94240	caps	for 94235	1/4" - 2"
94245	nipples	rubber	3/8" - 1 3/16"



Typical Cenco Vacuum Connectors

The Hyvac pump is provided with a one-piece intake nipple. As supplied, the nipple is intended primarily for use with rubber tubing. When glass connections are used between the pump intake nipple and the system, it is recommended to use a short rubber hose as a coupling between nipple and glass tube.

When tapered glass joints or ball joints are used in connections, a vacuum stopcock grease (No. 15517-1 or No. 15522) should be applied to both members.

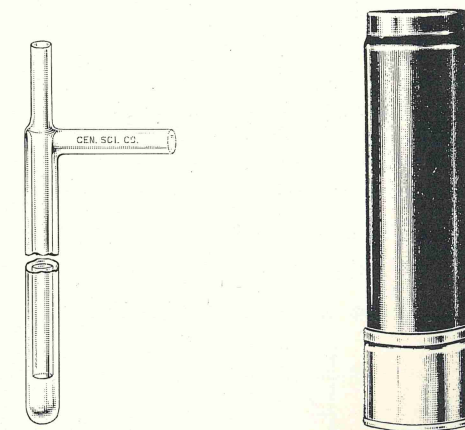
Rubber tubing connections should be kept as short as possible and made with an extra heavy wall, gum tubing, such as No. 18204, which has been compounded specially for vacuum work. All connections to metal or glass tubing should fit snugly and both members should be coated with vacuum stopcock grease.

2.4 valves

Metal vacuum valves and glass stopcocks are employed generally in the connecting line between the pump and the system to provide a means of connecting the vacuum gage and for vacuum release when stopping the pumping. When metal pipes are used for the line, a high-vacuum valve such as No. 94551 is recommended.

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of testing the pump, and system for leaks by the "pressure rise" method without disconnecting the pump from the line.

2.5 traps



No. 94005 liquid air trap No. 15830-3 Dewar flask

Extreme care must be taken to prevent solid particles from reaching the intake of the pump. They will score the working parts of the pump and reduce its efficiency. If corrosive vapors are in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor from the pump from entering the system. A Cenco No. 94005 or No. 94006 Glass Trap is recommended. Either should be used in a No. 15830-3 Vacuum Flask. The refrigerant most commonly used in the vacuum flask is a mixture of solid carbon dioxide (dry ice) and acetone or ethyl alcohol.

CONDUCTANCE OF TUBES FOR AIR AT 20°C

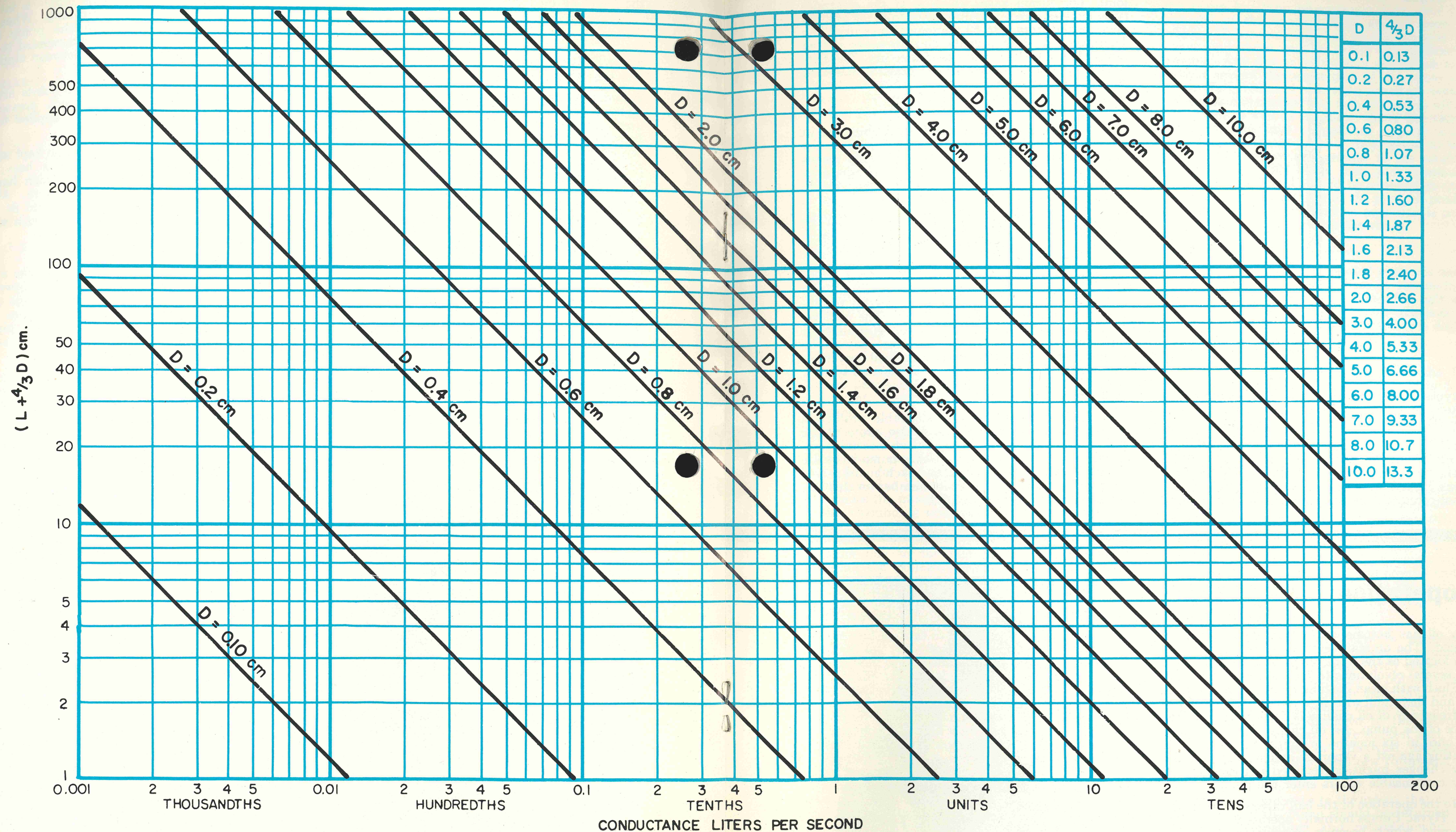


Fig. 3.

TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain pumping speed (S) as large as possible, the tube conductance (Z) must be very large as compared with the speed of the pump (S_1), as is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} \cdot S_1$$

Since at best (S) is only a fraction of (S_1), the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance, (Z), shown in litres/sec, is plotted as abscissas against the quantity ($L + \frac{4}{3}D$), in cm., as ordinates. In addition to the parameter D, the value of $\frac{4}{3}D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the value of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm. long having a diameter of 2 cm. is required. From the table, for D=2, it is seen that $\frac{4}{3}D = 2.66$ cm. Referring to the curve, for D=2 the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines, spaced logarithmically, conductance of tubes having other diameters than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

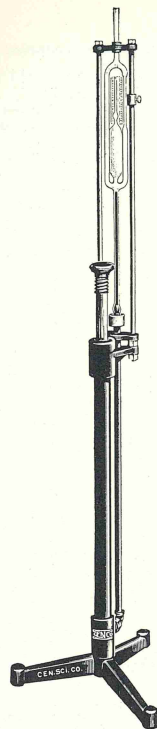
When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely

$$\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$$

where Z is the resultant conductance of tubes having individual conductances, b_1 , b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

2.6 gages



No. 94151 McLeod gage

The types of high vacuum gages commonly used in a system employing a Hyvac pump are the McLeod, Pirani, Discharge, and Thermocouple gage.

A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 mm Hg to 1.6 mm Hg (0.5 microns Hg to 1600 microns Hg). The outlet tube of this gage should be glass-connected to the system between the pump

and the freezing trap by a direct seal or a sealed joint. The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 microns and from 1 to 50 microns of mercury. The Thermocouple gage permits measurements in the range from 1 to 1000 microns of mercury. The Discharge gage operates within the range of 0.001 to 20 microns of mercury.

2.7 oil and drain valve

The oil drain valve is removed during shipment in order to prevent damage. Before adding oil to the pump, remove the pipe plug and replace by means of the drain valve. Best seals will be obtained by applying Glyptal to the drain valve thread before screwing into the pump housing.

The Hyvac is shipped with the oil drained from the reservoir. One quart of oil is supplied with each pump for the first filling and for periodic oil changes. To fill the pump with oil, first remove the exhaust dome and fill through the opening otherwise taken by the exhaust dome up to the oil level sight gage. Turn the pump pulley several revolutions by hand while filling with oil. The oil level window indicates the correct oil level. If insufficient oil is used, a good seal around the vanes may not be maintained. If too much oil is used oil may back up through the pump trap into the vacuum system.

2.8 belt guard

A well designed guard is a desirable protection against personnel hazards, and also protects the pump from damage caused by objects becoming entangled in the belt or pulley. Cenco pump bases are drilled to receive the guards, and each guard is sold ready for mounting. The order number for this belt guard is given in Paragraph 5.2.



3 operation

When oil has become contaminated it should be changed. The oil may be removed by opening the drain located at the front of the housing. Turn the shaft several revolutions to force out any remaining oil. Flush with clean flushing oil No. 93060 at least once and then refill with new Hyvac Oil No. 93050. The frequency of oil change is dependent upon the service of the pump. An oil change may be needed only once in six months or longer if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosion and easily condensable vapors enter the pump.

Due to the operation of the ball valve in the exhaust stage, Hyvac Pumps normally operate with a clicking sound which becomes sharper as the pump warms up and the pressure reduced.

On continuous duty the oil temperature may reach 50° to 60°C. This is normal for efficient operation of the pump.

4 maintenance

4.1 general

The maintenance requirements of the Cenco Hyvac Pump will vary with application. Proper lubrication is the most important factor in securing reliable performance. (See paragraph 2.7).

If a pump is connected into a normal leak-free system, there should be no condition which should cause the pump to malfunction that cannot be remedied by simple adjustments. If a pump fails to function, the cause usually can be attributed to a broken spring, a sticking vane or worn valve release and not a misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal use, therefore, where no corrosive vapors are encountered, it is reasonable to expect that there will be no decrease in the efficiency of a pump over a period of several years.

4.2 shaft seal

The stuffing-box nut on the pump shaft bearing should be tightened occasionally to take up wear in the packing, thus preventing leakage of oil at this point. New packing may be needed from time to time.

4.3 exhaust valve

It is quite possible, after many hours of pump operation, for the exhaust valve retainer to wear from constant hammering of the ball valve. This will cause the pump to lose efficiency, spray oil and make a pounding noise because the ball valve has either dropped out entirely or is traveling too great a distance. The pump will not reach its guaranteed vacuum due to the fact that oil is continually entering the exhaust opening. The valve retainer and the ball valves can be replaced very easily after removing the pump mechanism from its case.

4.4 vanes

Vanes and springs in the Hyvac Pump can be inspected by removing the top plate. A broken spring will prevent the vane from riding snugly against the rotor during its cycle of operation thus causing a failure in operating efficiency. Vanes may be inspected occasionally but the process must be accomplished with extreme care. The vanes should be removed one at a time and not under any circumstances be interchanged or reversed in position. The vanes may be removed after the springs have been released. By turning the pump by hand, one can determine how much of the vane is protruding above the surface of the pump housing and any markings on this part of the vane will do no harm. It is our practice to pull the vanes out with sharp nosed pliers, but extreme care should be taken to see that the nose of the pliers does not extend down over the part of the surface which slips into the vane slot housing. The vanes might be rather difficult to remove because they are usually under

atmospheric pressure. This is true particularly if the pump has been in operation just prior to the removal of the vanes. There are no loose parts which will become disturbed by the removal of the vanes and these can be taken out without any trouble. Any dirt or particles of grit which may be lodged around the upper part of the vanes should be carefully removed before the vanes are taken out since this material getting into the pump will score the stator as well as the rotor. After the vanes are removed, they may be polished slightly with the very finest of emery paper if they appear to be corroded. The vanes are ground to an established tolerance of 0.0005 of an inch and, therefore, no portion of the metal should be removed during the polishing process. As long as the pump is producing a satisfactory vacuum and no corrosion is present, it is advisable not to polish the vanes.

4.5 belt

The belt adjustment in mounted pumps is made by loosening the bolts in the base of the motor and moving in the required direction. The belt should be just tight enough to prevent slippage while operating. A little slippage on starting is desirable.

4.6 repairs

Fig. 4 shows cross sectional view of the Hyvac Pump. Paragraph 5.1 lists all the parts for the pump. When ordering replacement parts, please state the exact part number. For repairs to the pump other than the replacement of the shaft seal and where adequate shop facilities are not available, it is strongly recommended that the pump be returned to the factory.

Some parts are sold only to customers maintaining adequate shop facilities and experienced mechanics. Cleaning and replacing old parts, unless badly worn, is recommended as safer practice than attempting to refit new parts without the necessary tools and experience. Exhaust and intake vanes are supplied with one side only machined and ground and must be finished to fit the vane slot by the customer if it is impracticable to return the pump to us for repair.

Because of the great difficulty in refitting new rings P60799 and P60800 in order to obtain absolute concentricity of the rotor with respect to the rings, these parts are sold only to pump users thoroughly experienced in pump assembly. Long experience in repairing pumps has proved that rings are seldom worn or damaged to the extent that replacement is necessary. We suggest that the old rings, if not scored or otherwise damaged, be cleaned and reinstalled, with new rotors and vanes, if these latter parts are badly worn.

If pump parts are worn to the extent that new rings are necessary, the pump should be returned to our shop for overhauling and reconditioning. It is quite possible for an experienced mechanic to install new rings, but the task requires a special tool in order to locate dowel positions for drilling and to establish proper concentricity of the rotor with respect to the ring bore.

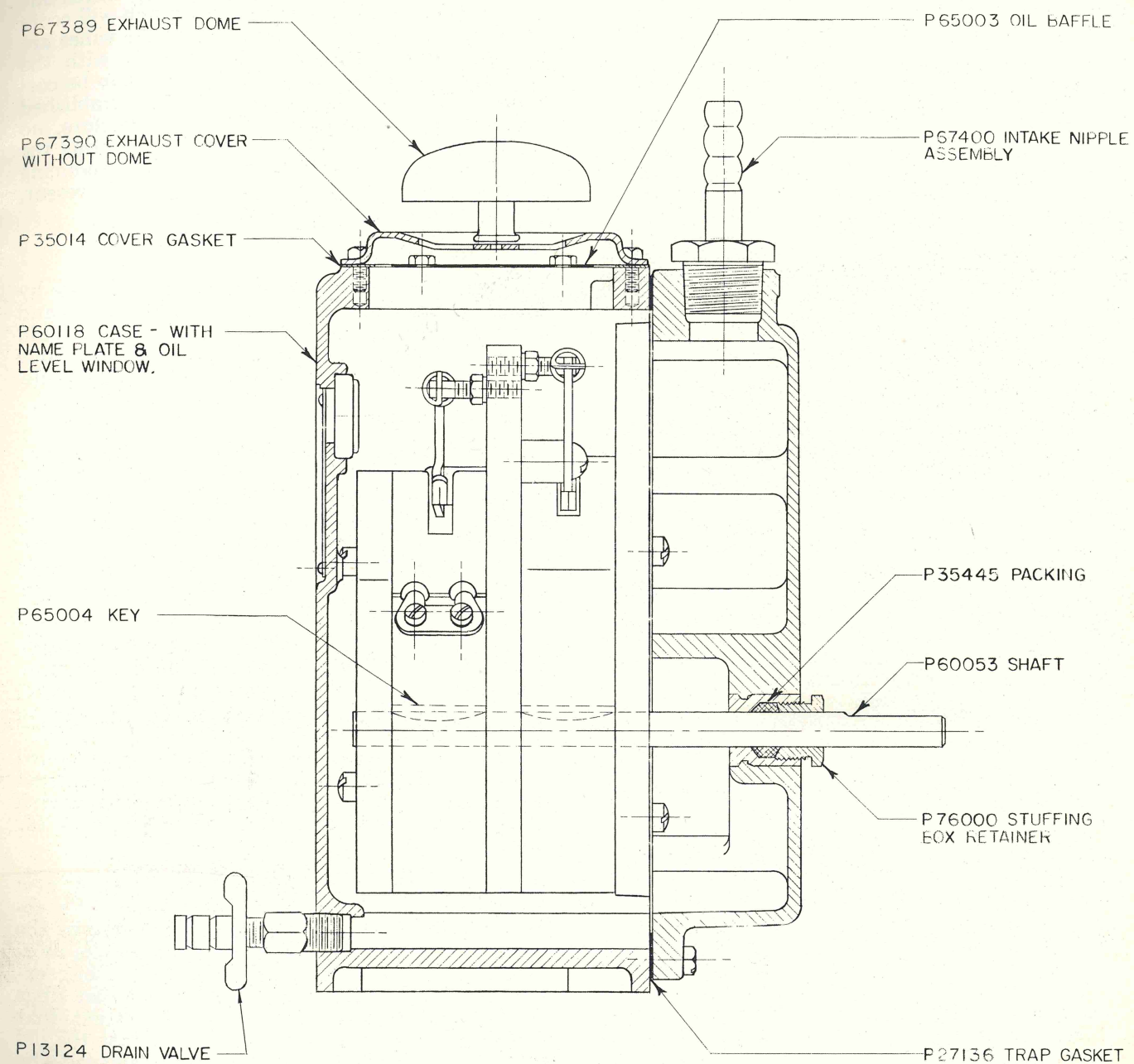


Fig. 4, Sectional View of Hyvac Pump

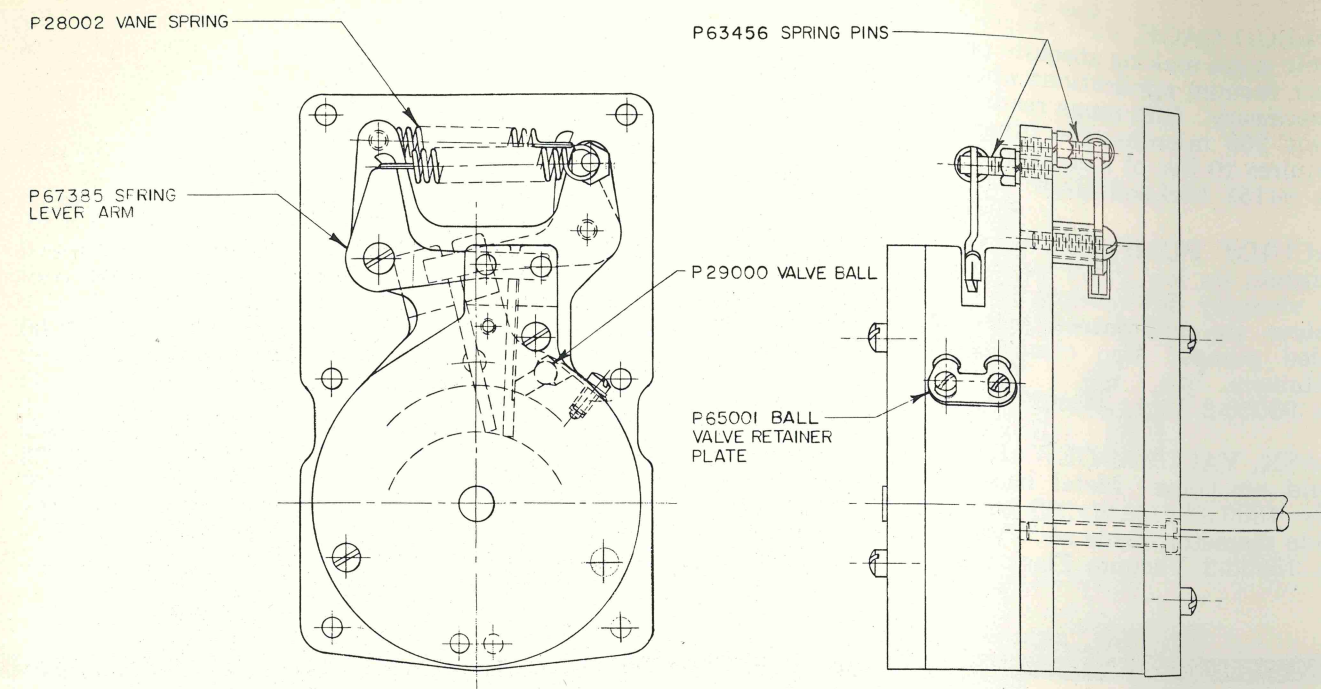


Fig. 5. Spring vanes and valve positions

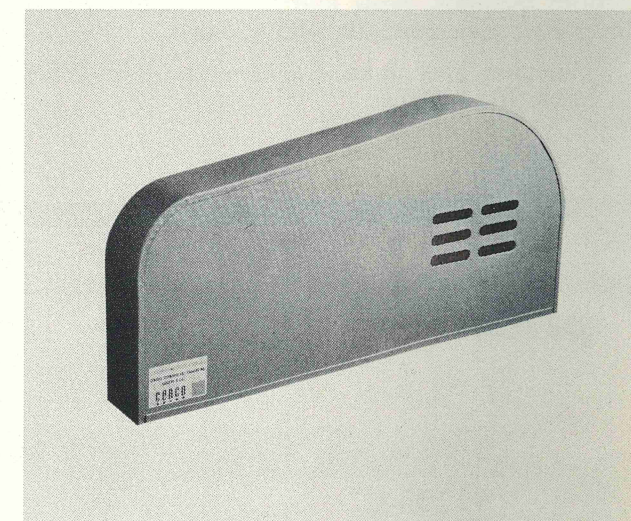
5 replacement parts and accessories

5.1 replacement parts

Part Description	Parts per Pump	Part No.	Prices
2 Ring, Exhaust	1	P60800	\$11.00
2 Ring, Intake	1	P60799	9.75
2 Rotors	2	P60031	7.50
Shaft	1	P60053	2.25
Finished Pump Case (Without Trap)	1	P60118	12.50
(Complete with Name Plate & Drive Screws for attaching same & Oil Level window).			
2 Vane (Intake)	1	P60648	1.50
2 Vane (Exhaust)	1	P60649	2.25
Spring Pins	2	P63456	.20
Nipple	1	P63029	1.00
Dome	1	P67389	2.00
Cover (Without Dome)	1	P67390	2.25
Oil Baffle	1	P65003	.15
Spring Lever Arms	2	P67385	1.50
Cover Gasket	1	P35014	.25
(As replacements for pumps with Serial No. 25650 and above. Also can be adapted to pumps with Serial Nos. between 19000 & 25650.)			
Trap Gasket	1	P27136	.50
Packing, Shaft Seal	1	P35445	.30
Key	2	P65004	.40
Stuffing Box Retainer	1	P76000	.50
Vane Springs	2	P28002	.25
Ball Valve Retainer Plate	1	P65001	.10
Valve Balls	2	P29000	.10
Belt	1	91131	2.00
Prices Subject to change			

2 Only sold to customers with adequate shop facilities and experienced personnel.

5.2 accessories



BELT GUARD for enclosing the pump and motor pulleys and belts where moving parts constitute a personnel hazard. Comes ready to screw to tapped pump base.

No. 91135 Belt Guard\$14.75

VACU RULE, a handy slide rule for calculating low pressure conductance, system evacuation times, and typical vacuum conversion factors.

No. 94008 Vacu Rule\$1.00

Requires 10 lbs. of mercury.
No. 94151 McLeod Gage\$205.00

No. 93050-2 Light Pump Oil, per quart.....\$.75

No. 15830-3 Vacuum Flask	\$12.25
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No. 94005 Liquid Air Trap\$6.50

No. 94006-1, 25 diameter, 12 mm tubes.....	\$21.00
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No. 84097 Adapter\$.38

6 bibliography

High Vacuum Apparatus, Bulletin 10, Central Scientific Company

Vacuum Pumping Equipment and Systems, H. M. Sullivan, Rev. Sci. Inst. 19, 1 (1948)

Vacuum Systems, Seals and Valves, Franz N. D. Kurie, *Rev. Sci. Inst.* 19, 485 (1948)

High Vacuum Technique, J. Yarwood, (John Wiley and Sons, Inc.) 1955

High Vacua, Swami Jnanananda, (D. Van Nostrand Company, Inc.) 1947

Scientific Foundations of Vacuum Technique, Sauerbrey, (John Wiley and Sons, Inc.) 1949

Vacuum Technique, Arnold L. Reimann (Chapman Hall Ltd., London) 1952.

Industrial High Vacuum, J. R. Davy (Sir Isaac Pitman & Sons, Ltd.) 1951

7 price list

CENCO NO.	MOTOR RATING	PRICE
91105-1	115 V. 60 Cycle	\$119.00
91105-2	230 V. 60 Cycle	129.25
91105-3	115 V. D.C.	171.00
91105-4	230 V. D.C.	165.50
91105-5	115 V. 25 Cycle	150.00
91105-7	115 V. 50 Cycle	129.25
91105-8	230 V. 50 Cycle	134.50
91105-10	115 V. 60 Cycle	150.00
	(explosion proof)	
91105-23	Without Motor	101.00

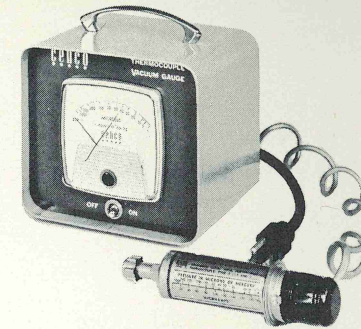
high vacuum gages

THERMOCOUPLE VACUUM GAGE for measuring pressures in the range of 1 to 1000 microns of mercury, read directly on a single meter scale. Gage head is shock resistant and cannot be damaged by exposure to atmospheric pressure. Voltage regulation circuit makes this light weight unit insensitive to operating line voltage changes (115 volts, 60 cycles A.C.).
 No. 94178 Thermocouple Gage\$110.00

DISCHARGE VACUUM GAGE AND CONTROLLER for direct reading of pressures between .001 and 20 microns of mercury on a single scale. Gage head is shock resistant and unaffected by atmospheric pressure. Transistor amplifier circuit activates relay at any pre-set pressures to either start or stop auxiliary equipment. Operates on 115 volts, 60 cycle A.C. and will control external equipment drawing up to 1 ampere without having to use relays (Cenco Nos. 99720-1 or 99725).
No. 94183 Discharge Gage\$249.50

PIRANI GAGE, improved design based on hot-wire principles, for direct readings from 1 to 2000 microns of mercury in two scales. Measures total pressure of condensable vapors and gases in the complete system. Output for 10 millivolt recorder. Operates on 15 watts, 115 volts, 60 cycle A.C.

No. 94185 Pirani Gage	\$196.00
-----------------------------	----------



THERMOCOUPLE



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Please Cut Out
Along Dotted Line

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TO:

Institution, Company, or Individual

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Sig. of Authorized Official

City

State

Title

ATTN:

CHARGE
TO:

Institution, Company, or Individual

Order Number

Street Address

City

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ATTN:

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CAT. NO.

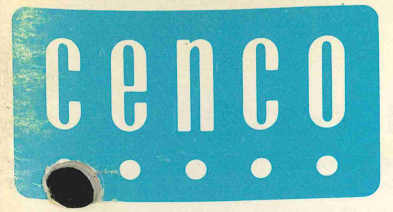
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Booklet 320

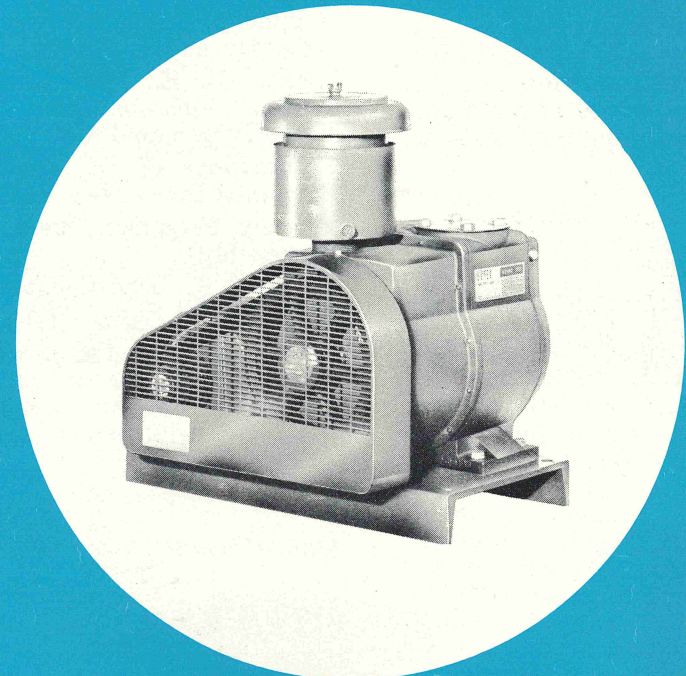
Central Scientific Co.
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CHICAGO, ILLINOIS 60613



mechanical vacuum pumps

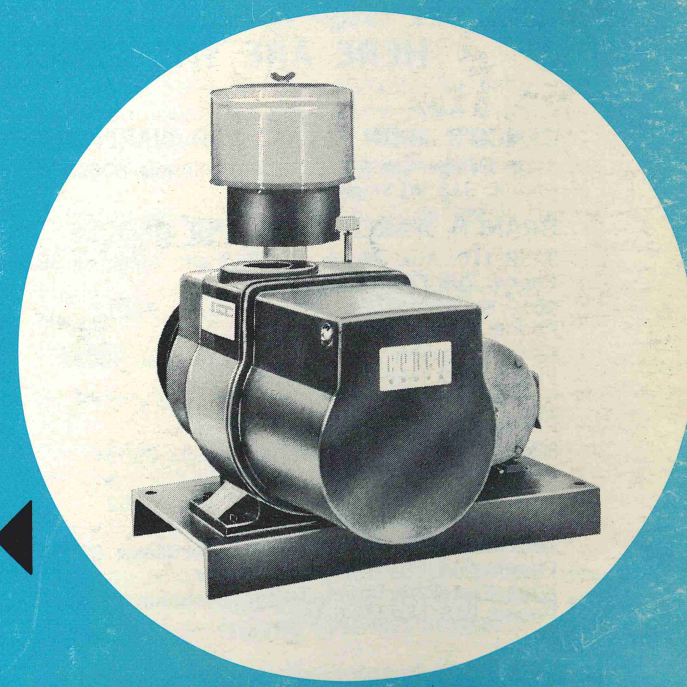
A COMPLETE LINE OF HIGH VACUUM PUMPS, GAGES, SYSTEMS, & COMPONENTS
MAKERS OF THE WORLD RENOWNED HYVAC® PUMPS

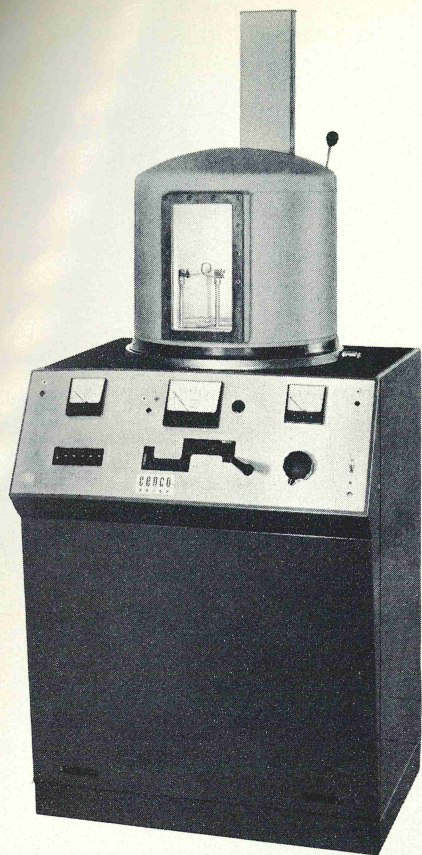
CENCO HYVAC PUMP



A two-stage, oil sealed mechanical pump of the internal moving vane design for pumping down to 0.05 microns of vacuum with high speed. Its reasonable cost and size make this dependable pump ideal for research and educational laboratory applications. It has also found wide acceptance in the chemical process industry where a continuous high vacuum is required.

GUARANTEED VACUUM (millitorr of mercury)		CAPACITY at atmosphere at 1 millitorr (liters per min.) (liters per min.)		BOOKLET	
SINGLE STAGE PUMPS				329	
	Hyvac 7	10.0	79		—
	Hyvac 14	5.0	140		—
	Hyvac 28	5.0	280		—
	Hyvac 45	5.0	450		—
DOUBLE STAGE PUMPS	Pressovac	15.0	35	—	325
	Blower Pump	3 IN. Hg.	35	—	326
	Hyvac	0.3	10	5	320
	Hyvac 2	0.1	25	13	321
	Hyvac 4	0.05	48	25	
	Hyvac 6	0.1	65	30	
	Hyvac 7	0.1	79	35	
	Hyvac 14	0.1	140	75	
	Hyvac 28	0.05	280	150	319
	Hyvac 45	0.05	450	280	
Hyvac 150	0.05	1500	1275		
Hyvac 225	0.05	2250	1800	319	
Hyvac 300	0.05	3000	2250		
Megavac	0.1	57	22	323	
Hypervac 23	5.0	240	—	324	
Hypervac 25	0.1	264	120		
Hypervac 100	0.1	960	660		





NO. 94700 LABORATORY VACUUM SYSTEM

A light weight, compact unit designed to be used in research laboratories, industrial production and pilot plants, where a completely self-contained unit is required for a wide variety of vacuum applications. This unit is ideal for high vacuum deposition of metals on optical and other surfaces.

A 19-inch diameter pump plate is connected through the Cenco Three-Way Valve to a high speed diffusion pump backed by a Hyvac 14 mechanical pump. The Three-Way Valve replaces the roughing, foreline and high vacuum valves now used in conventional systems. The quick mechanical movement of its single lever operation eliminates the lack of reliability and high cost associated with pneumatic and solenoid operated valves. It also prevents costly errors due to operating valves in the wrong sequence. A built in water-cooled baffle minimizes backstreaming from the diffusion pump.

The bell jar can be evacuated within five minutes to a working vacuum of 1 micron of mercury as read on the vacuum discharge gage connected to the pump plate. A few more minutes of pumping will attain 0.1 micron—excellent for evaporation. The system is also equipped with a thermocouple gage which gives the foreline pressure to the operator, thereby indicating when to switch in the diffusion pump.

The implosion proof, aluminum alloy bell jar offers full visibility of the chamber interior through a large plastic window. The bell jar is raised by a self-contained spring-loaded hoist to quickly expose the pump plate and its nine electrodes. Twelve volts ac at 100 amperes are available at two pairs of electrodes. Four other electrodes are connected to external jacks on the front panel. They extend the versatility of the system by permitting electrical measurements of phenomena to be made from outside the bell jar or power to be introduced to operate rotating sectors or other devices in the vacuum chamber. The remaining electrode will maintain a glow discharge by a self-contained 5000 v power supply to clean objects before coating.

All prices F.O.B. our nearest branch as of publication date. Applicable taxes will be added. Exact current prices available on request. Terms: 30 days net.

We have attempted to describe accurately the merchandise listed in this bulletin. Additional information will be gladly given upon request. The company warrants that each item of merchandise sold by it is free from defective workmanship or material upon return of the same to the company office at Chicago, Illinois. This warranty is made in lieu of all other warranties, express or implied, and no other warranty, express or implied, is assumed or will be assumed.

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1 introduction

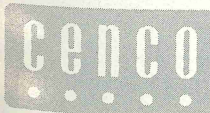
1.1 General: The Cenco Hyvac 150, 225, and 300 Pumps are two-stage, high-capacity mechanical vacuum pumps based on Gaede's internal-vane principle. Combining quiet, vibrationless operation, and high pumping speed with low ultimate pressure, the Cenco 150, 225, and 300 Hyvac Pumps are best suited for heavy-duty vacuum work, such as evacuating space chambers, pumping down large vacuum furnaces, and backing ultra-vacuum diffusion pumps in environmental testing and space condition simulation. These pumps may also be used as roughing pumps in general-purpose high vacuum applications and as forepumps in conjunction with diffusion pumps, such as Cenco Nos. 93415 and 93416. Specifically, the Cenco Hyvac Pumps can be used in the following high-vacuum commercial applications:

- **Vacuum Metallurgy** — Thermal Reduction, Distillation of Metals, Vacuum Sintering, Heat Treatment, Vacuum Melting
- **Vacuum Dehydration** — Blood Plasma, Biologicals, Foods
- **Vacuum Evaporation** — Low-Reflection Coatings on optical surfaces and reflecting surfaces, Decorative Coatings, Electrically Conductive Coatings
- **Vacuum Sputtering** — Coating of Non-Conductors
- **Vacuum Distillation** — Distillation-Point Reduction, Molecular Distillation
- **Vacuum Impregnation** — Condensers, Coils, Transformers, Cables, and other electrical insulating materials

- **Miscellaneous** — Manufacture of Refrigerators, Bellows-type Barometers, Vapor-operated Thermometers; Television Receivers, Vacuum Bottles, etc.; Evacuation of High-voltage X-ray Tubes, Large Magnetrons, Cathode-Ray Tubes.

1.2 Plus Features of Hyvac 150, 225, and 300 Pumps

- A special valving arrangement for easy start-up even when the stages are filled with oil—a condition which results when the pump is stopped and allowed to remain under vacuum.
- A rotor specially designed to increase the capacity of the pump.
- High-conductance, internal connections between intake and exhaust stages for optimum performance.
- A separate chamber, incorporated within the rotors, for outgassing the pump oil. Sufficient conductance between rotors permits degassing by the exhaust stage at a very high rate.
- A centrifugal oiling system to force oil from inside the hollow rotors through the clearances between rotor and end plate as the rotors spin. This oil flow lubricates the moving parts and serves also as sealant between stages.
- Sufficient volume in the rotor chamber to allow retention of the oil that usually seeps into the pump when the latter is stopped while still under vacuum. This feature minimizes the possibility of oil backing into the vacuum system.



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2 principle of operation

2.1 Single Stage Pump: Since the Hyvac 150, 225, and 300 Pumps incorporate two, distinct, single stages mounted back to back, to understand how a two-stage pump works, it is only necessary to understand the operating principle of a single-stage pump.

A typical, internal-vane, vacuum pump consists of a motor-driven cylindrical rotor eccentrically mounted within a larger housing, or stator. Two spring-loaded vanes are mounted in the rotor, parallel to its axis, in diametrically opposed slots. The vanes bear against the wall of the stator under spring pressure and centrifugal action. The eccentric mounting of the rotor provides a permanent point of contact between stator and rotor and divides the stator in two sections, or stages: intake and exhaust. A thin film of oil at the point of contact maintains effective vacuum sealing, thus preventing the passage of gas between stages. Two openings in the stator serve as gas intake and exhaust ports. The intake port is connected to the system to be evacuated.

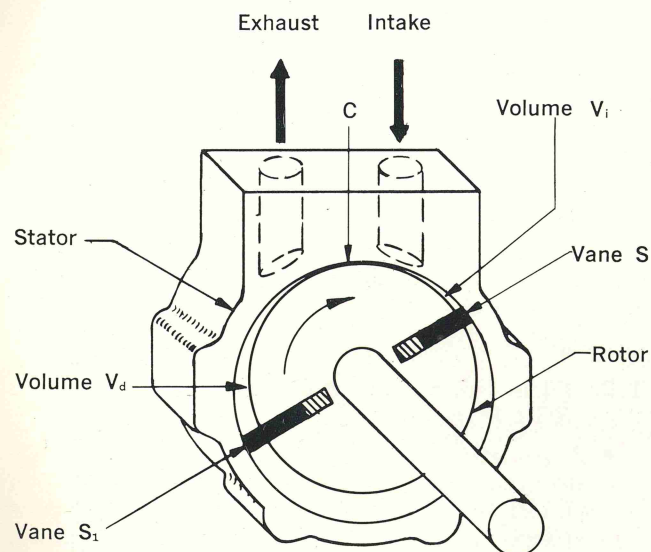


Fig. 1—Operating principle of an internal-vane vacuum pump

Figure 1 illustrates the internal vane principle, on which Gaede built his "Kapselpumpe" in 1910. As the pump is driven by a motor, the rotor turns, and the spring-loaded vanes slide in and out of their slots, maintaining positive contact with the wall of the stator throughout every revolution. As a result, gas in the space between the two vanes is pushed forward, compressed to atmospheric pressure, and expelled through the exhaust while additional gas is sucked in through the intake. As the rotor turns, the volume behind vane S_2 increases from the instant vane S_1 slides past the

sealing area, or contact point C . This increasing volume V_i allows more gas from the system being evacuated to enter the intake stage. At the same time, the volume V_d ahead of vane S_1 decreases, thereby forcing gas to be compressed and expelled from the exhaust stage. The compressed gas is kept from entering the intake stage by the oil seal at the contact point C . A single stage pump of this type produces a vacuum of about 5 millitorr.

2.2 Two-Stage Pump: A typical vacuum pump of this type consists of two pumping stages, a high-vacuum stage and a roughing stage, connected in series. The stages are mounted side by side and are separated by a common wall—ground plane parallel—through which a hole has been drilled. The hole serves as both the exhaust port of the high-vacuum stage and the intake port of the roughing stage. While volume V_d in the former is decreasing, air is being expelled in volume V_i of the roughing stage. The air in the volume V_d of the high-vacuum stage is not compressed appreciably; as a result, leakage into the high-vacuum stage is minimized. A two-stage pump of this type produces a vacuum of 1 millitorr or better.

3 specifications

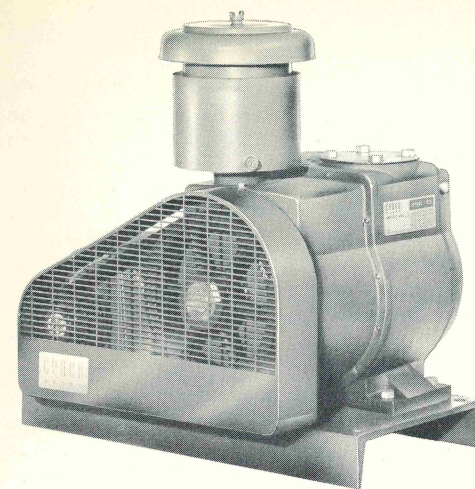
3.1 Pump Data: The speed-pressure characteristics of the Cenco Hyvac 150, 225, and 300 Pumps are illustrated in Fig. 2. The following table lists additional pump data and specifications:

Pump Model Cenco No.	Hyac 150 91957	Hyac 225 91959	Hyac 300 91960
Capacity			
at atmospheric pressure,			
liters/minute	1500	2250	3000
cubic feet/minute	53	79	106
at 1 millitorr,			
liters/minute	1275	1800	2250
cubic feet/minute	46	63	79
Guaranteed Vacuum, millitorr	0.05	0.05	0.05
*Merit Factor, %	85	81	75
Pump Speed, rpm	465	465	465
Oil Required, quarts	20	24	28
Overall Dimensions, inches			
Length	31	31	31
Width	22½	27	30½
Height	29½	29½	29½
Intake Flange Data			
Opening, OD, inches	3⅛	3⅛	3⅛
Bolt Circle, OD, inches	5½	5½	5½
Bolt Holes, NC thread	5/8-11	5/8-11	5/8-11

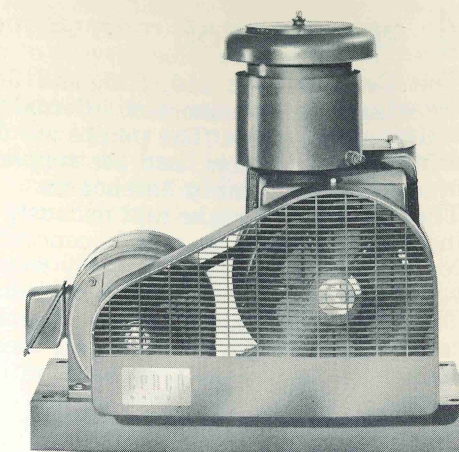
*Merit factor is the ratio of the pumping speed at 1 millitorr to the pumping speed at atmospheric pressure.

3.2 Motor data

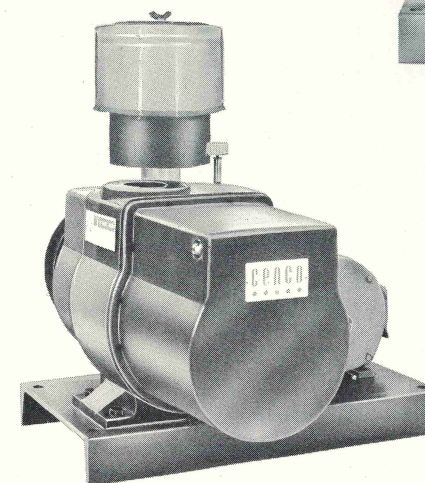
	Hyac 150, 225 and 300
Motor Horsepower	3
Motor Type, phase	3
Voltage, volts	220/440
Frequency, cps	50/60
Power Demand, watts	
at 50 cycles	2770
at 60 cycles	2330



HYVAC 150



HYVAC 225



HYVAC 300

Cenco Double-Stage, High-Vacuum Pumps: Hyvac 150, 225, and 300

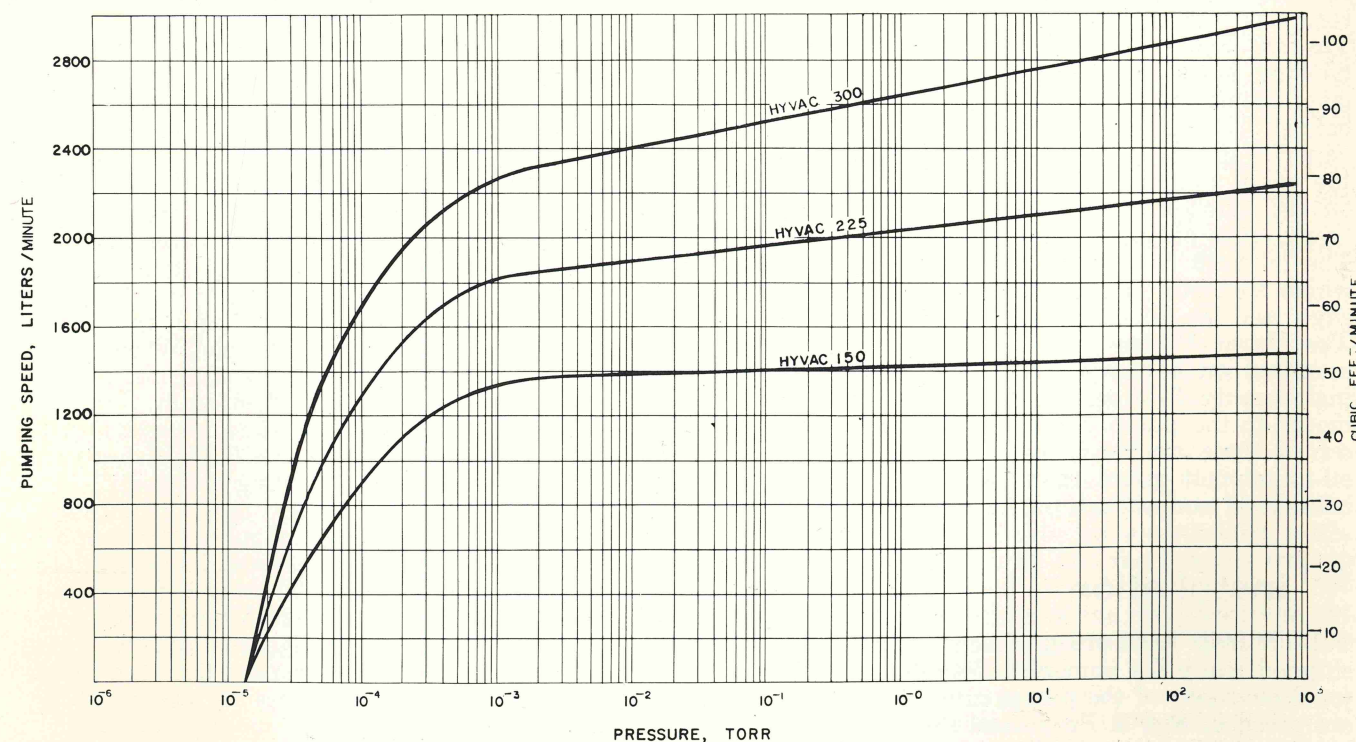


Fig. 2—Pumping speed and pressure characteristics of the Hyvac 150, 225, and 300 pumps

4 description

The Cenco Hyvac 150, 225, and 300 Pumps are two-stage, series-connected, internal-vane, mechanical vacuum pumps. The pumps are driven by powerful, electric motors, and are supplied unmounted or mounted on sturdy baseboards.

The two stages, intake and exhaust, consist of cylindrical chambers in which concentrically driven rotors are mounted eccentrically to provide a high-vacuum seal between the rotors and the chambers. The intake and exhaust ports of each stage are located on both sides of the sealing area. Two spring-loaded, sliding vanes are mounted in the slots of each rotor.

For easy startup, the Hyvac 150, 225, and 300 Pumps are provided with fly-away, flat steel valves which open when the pressure in the pump exceeds 15 psi, and allow excess oil to be discharged to atmosphere without first being circulated through the exhaust stage. Another important component of the valving system is a double-purpose exhaust valve used to discharge excess oil from the exhaust stage. One part of the valve is a spring-loaded, heavy steel plate which covers a 2-inch square hole. This plate opens when large quantities of gas and oil are being exhausted. The other part of the valve is a thin, spring-steel plate which covers four 5/8-inch holes. This plate opens to exhaust the usual small quantities of gas encountered at low operational pressures. The Pump mechanism is completely immersed in oil. The oil bath insures a vacuum-tight seal of the stages; cools the pump interior; and lubricates the moving parts through the oiling holes. The lubricating oil is degassed by the exhaust stage before it is allowed to reach the intake stage. Eventually, the oil becomes contaminated with volatiles and water droplets, and it must be replaced.

To prevent contamination of the pump oil when condensable vapors are pumped, a gas ballast feature has been incorporated in the Hyvac pumps. The gas ballast valve, located at the rear of the housing, allows regulation of the air flow (gas ballast) during the compression cycle of the stage. This ballast flow reduces the compression ratio of the vapor in the stage, thus preventing condensation of the vapor and emulsification with the oil. Mounted on the pump is an exhaust-filter dome that effectively traps oil in the exhaust.

The oil bath is contained within two housings on which are mounted the drain cock, the oil level sight gage, and the oil shaft seal.

The Hyvac Pumps 150, 225, and 300 are shipped mounted on a heavy metal base together with a high-quality, 3-hp motor. A belt drive connects the motor to the pump. Supplied with each pump is a set of three matched, molded-rubber V belts, an all-metal belt guard that completely encloses the belt drive, and enough oil for one filling.

5 installation

5.1 Pump Mounting: Each mounted pump is shipped ready for immediate installation. The major dimensions of the pump, pump base and motor are given in Fig. 3. Provisions should be made for bolting the base to the floor or, if the pump is to be used in a movable unit, to the frame. When electronic equipment is attached to the same frame, shock mounts should be installed so that vibrations

from the motor or pump will not be transmitted through the frame.

A pump should be mounted perfectly level so the oil level can be read accurately. The rotation of the pump pulley must be clockwise when viewed from the pulley side of the pump.

5.2 Motor Connections: Motors supplied with the Hyvac 150, 225, and 300 require permanent connections. Connect the motor to a power line of the voltage, frequency and phase indicated on the nameplate of the motor. The power line should be heavy enough to carry the current required without causing any undue drop in voltage. All motors can be operated on across-the-line start.

Remember that fuses provide short-circuit protection only for the power supply line; they do not protect the motor from overload. For correct selection of the power-line fuse, consult Table I. A suitable starting switch with motor overload protection should be used for all permanent installations.

Table I
ELECTRICAL DATA

Current Demand, amps	
at 220 volts, 50 cps	12.6
at 220 volts, 60 cps	10.6
at 440 volts, 50 cps	6.3
at 440 volts, 60 cps	5.3
Maximum Line Fuse Rating, amps	
at 220 volts	60
at 440 volts	30

5.3 Vacuum Connections: The Hyvac 150, 225, and 300 pumps are provided with 2 1/2 inch ASA standard flange connections. It is recommended that the following procedure be observed when making any vacuum connections:

- (1) Remove the plastic protective cover from the intake flange of the pump.
- (2) Remove the plug from the exhaust port, and install the exhaust dome.
- (3) When connecting the pump to the system to be evacuated, take extreme care to eliminate any source of leakage.
- (4) Make sure that both members of each connection are coated with vacuum stopcock grease and that all connections to metal tubing fit snugly. It is best to solder or braze all metal connections.
- (5) If threaded pipe joints are used, the threads should be as perfect as possible. When making threaded connections, screw the members together a few turns, and then apply Glyptal to the exposed threads before screwing them tightly together. Allow the Glyptal to dry for several hours before starting the pump.
- (6) If flanged connections are used, install flat or "O" ring gaskets, made of rubber or Neoprene, between the flanges to prevent leakage. Place a thin coat of oil on the "O" ring before installation. Cenco No. 90020-25 Vacuum Seals may be used for intake flange connections. Cenco also manufactures an extensive line of couplings, connections and accessories for use in high vacuum systems.
- (7) For maximum gas flow and minimum pressure drop, make all vacuum connections as short as possible, and use tubing of as large a diameter as possible.

The conductance of various sizes of tubes can be calculated by means of the Cenco Vacu Rule, Cenco No. 94008, or may be determined from Fig. 4, in which the quantity $(L + \frac{4}{3}D)$ is plotted against Z , the conductance in cubic centimeters per second. The symbols L and D represent the length and inside diameter of the tubes in centimeters. The average pumping speed of the system, then, may be found by solving the following relationship:

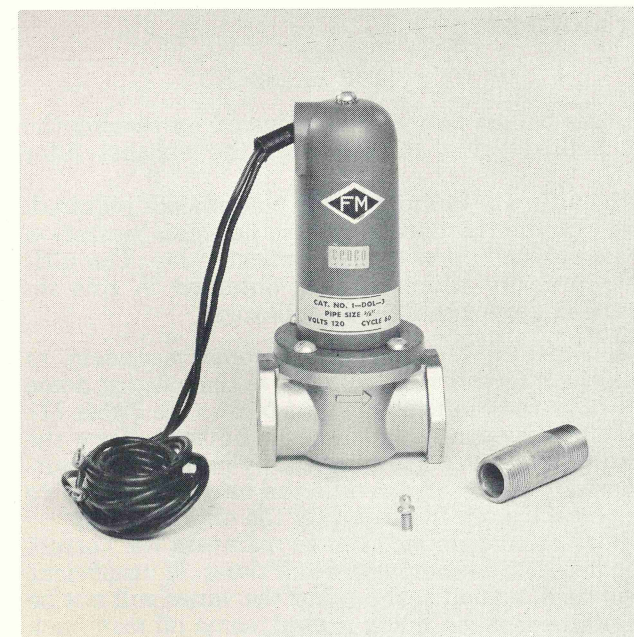
$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

where S_1 is the pumping speed, taken from Fig. 2, and Z is the conductance of all the tubing or the connecting line between the pump and the system. The time required to evacuate a vessel of volume V is given by the formula:

$$T = \frac{2.3V}{S} \cdot K$$

where T is the time in seconds, V the volume of the vacuum system expressed in liters, and S the average pumping speed expressed in liters per second, for operation from atmospheric to final pressure. The factor K has values of 4, 5, and 6. The value 4 is used for a final pressure of 100 millitorr, 5 for 10 millitorr, and 6 for 1 millitorr.

5.4 Valve Connections: Generally, metal vacuum valves and glass stopcocks are employed in the connecting line between the pump and the system for connecting the vacuum gage and for releasing the vacuum system after pumping has been terminated. When metal tubing is used, a high-vacuum valve, such as No. 94551 or 94280, is recommended.

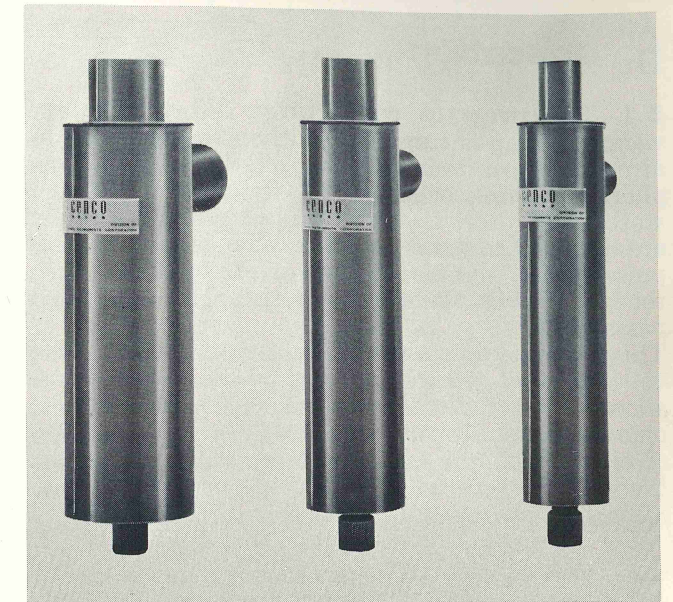


Low-Pressure Solenoid Valve, Cenco No. 94280

In metal-to-glass and glass-to-metal lines, a large-bore, vacuum stopcock should be sealed into the line to provide a means of leak-testing the pump and the system by the pressure-rise method without disconnecting the pump from the line.

5.5 Vacuum-System Traps: Extreme care must be taken to prevent solid particles from reaching the intake of the pump, otherwise they will score the working parts of the pump and reduce its efficiency. If corrosive vapors are present in the system, a freezing trap must be used in the line to prevent them from entering the pump. Such a trap also prevents any oil vapor (from the pump) from entering the system.

A Cenco No. 94009 Liquid Nitrogen Trap is recommended for this purpose. For detailed specifications on the traps, refer to Section 8, Accessories.



Liquid Nitrogen Traps, Cenco No. 94009

If large amounts of water vapor are pumped and a large ballast flow is used, some oil mist will be discharged with the ballast air and vapor. It is a good hygienic practice to pipe the exhaust outside the work area. For this purpose, remove the filter dome and connect a 3-inch IPS pipe directly to the exhaust outlet. For best performance, a simple condensing trap should be provided in the exhaust line as close to the pump as possible to prevent the condensate, which will form in the pipe, from running back into the pump.

5.6 Gages: The types of high vacuum gages commonly used in a system employing a Hyvac pump are the McLeod, Pirani, discharge, and thermocouple gages.

A McLeod gage is recommended for the accurate reading of low pressures in the range 0.0005 mm Hg to 1.6 mm Hg (0.5 to 1600 millitorr). The outlet tube of this gage should be glass-connected to the system between the pump and the freezing trap by a direct seal or a sealed joint.

The Pirani gage, which is of the electrical type, enables direct measurements from 50 to 2000 millitorr and from 1 to 50 millitorr.

The Thermocouple gage permits pressure measurements in the range from 1 to 1000 millitorr.

The Discharge gage operates within the range of 0.001 to 20 millitorr.

All vacuum gages are illustrated and described in Section 8, Accessories.

5.7 Oil Requirements: Each Hyvac Pump is shipped with enough oil in the pump reservoir for operation. Before refilling, consult Section 6.3.

Table II
OIL REQUIREMENTS

Pump Model	Oil Supplied with pump, Gallons	Oil Required for one filling, Pints
Hyvac 150	5	40
Hyvac 225	6	48
Hyvac 300	7	56

6 operation

6.1 Starting up the Pump: When a rotary vacuum pump is turned off without being let up to atmosphere on its intake side, oil, driven by atmospheric pressure, begins to fill the volume between stator and rotor. Because the pump and its valves are designed to handle compressible gas, not incompressible oil, the electric motor often cannot turn the rotor over against the resistance of oil-filled passages.

This difficulty is never experienced with the Hyvac 150, 225, and 300 Pumps. The fly-away flat valves allow for direct discharge of excess oil to the atmosphere; the double-purpose valve permits exhaustion of oil through the exhaust stage. *If the pump has been properly installed, it will begin to pump immediately each time the motor is turned on.*

6.2 Gas Ballast: The gas ballast pump is ideally suited for pumping all vapors which do not chemically attack or dissolve in the pump oil; water is a typical example. Even after contamination of the oil has occurred, the gas ballast pump is able to purify the oil if the system is temporarily shut off from the pump and the pump kept running for a suitable length of time. The contaminated oil will continually circulate from the oil supply channel into the high vacuum side, where the contaminant will evolve as vapor. This vapor then will be discharged with the ballast air as described before, until eventually all the contaminant has been expelled. For this reason, the oil of a pump employing the gas ballast does not have to be changed as often as the oil of pumps which do not have the gas ballast. Although it is impossible to calibrate the gas ballast control for all pumps at all operating pressures, it is useful to know the effectiveness of different gas ballast flow rates on the pumping of vapors. The following formula will enable the user to calculate the maximum pumping rate of insoluble vapors without their contaminating the pump oil:

$$W = DV \cdot \frac{P_a}{P_e - P_s} \cdot \frac{T_p}{T_a} \text{ (g/min)}$$

where:

- T_p = pump temperature ($^{\circ}\text{K}$) (taken as pump oil temperature)
- T_a = ambient temperature ($^{\circ}\text{K}$)
- P_a = barometric pressure (torr)
- P_s = saturation pressure of pumped vapor at pump temperature T_p (torr)
- P_e = pressure under pump exhaust valve at instant of exhausting (torr)
- V = rate of dry gas ballast flow at atmospheric pressure P_a (lit/min)

D = density of pumped vapor at temperature T_p and pressure P_s (g/lit)
 W = maximum safe mass rate for pumping vapors (g/min)

Solving for the special and frequently encountered situation of pumping water vapor, and treating this vapor as a perfect gas, so that at exit,

$$D_{\text{water vapor}} = \frac{18}{22.4} \cdot \frac{P_s}{760} \cdot \frac{273}{T_p}$$

$$= 0.289 \frac{P_s}{T_p} \text{ (g/l)}$$

and, assuming a pressure of 850 torr below the exhaust valve at the instant of exhaustion, and then substituting the density of water vapor, we obtain as the maximum safe pumping rate for water vapor:

$$W_{\text{water vapor}} = 0.289 \left(\frac{V}{T_a} \right) \left(\frac{P_a P_s}{850 - P_s} \right) \text{ (g/min)}$$

Using 10 lit/min gas ballast flow, we obtain the maximum water-vapor pumping rates shown in Table III when no condensation is in the pump:

Table III
WATER-VAPOR PUMPING RATES

Pump Temperature in $^{\circ}\text{C}$	Maximum Water-Vapor Pumping Rate in g/min	
	With zero humidity in gas ballast air	With 100% humidity in gas ballast air
50	0.91	0.72
60	1.60	1.39
70	2.84	2.59
80	5.38	5.08

For above data

$$P_a = 760 \text{ torr}$$

$$T_a = 20^{\circ}\text{C} = 293^{\circ}\text{K}$$

The gas ballast flow can be adjusted by turning the gas ballast valve, located near the exhaust filter dome.

If the ultimate vacuum of the pump is not required, it is possible to obtain almost noiseless operation by "cracking" open the gas ballast valve. The ultimate pressure which can be obtained in this instance is approximately 30 millitorr.

6.3 Adding Oil: When it becomes necessary to refill the reservoir with oil, remove the exhaust dome and pour the required amount of oil (see Table II) through the opening in the drain housing. Turn the pump pulley several revolutions by hand while pouring oil in the reservoir. Fill the oil reservoir up to the correct level, indicated by the oil level gage. It is of utmost importance to maintain the correct amount of oil in the pump at all times. If insufficient oil is used, a good seal around the vanes will not be maintained; if too much is used, some oil may back up through the pump trap and into the vacuum system.

NOTE: Oil shooting from the exhaust dome of an operating pump indicates that the pump contains too much oil. If this happens, stop the pump and drain oil slowly until the oil level is at the proper height. It is good vacuum practice to take an occasional check of the oil level while the pump is running.

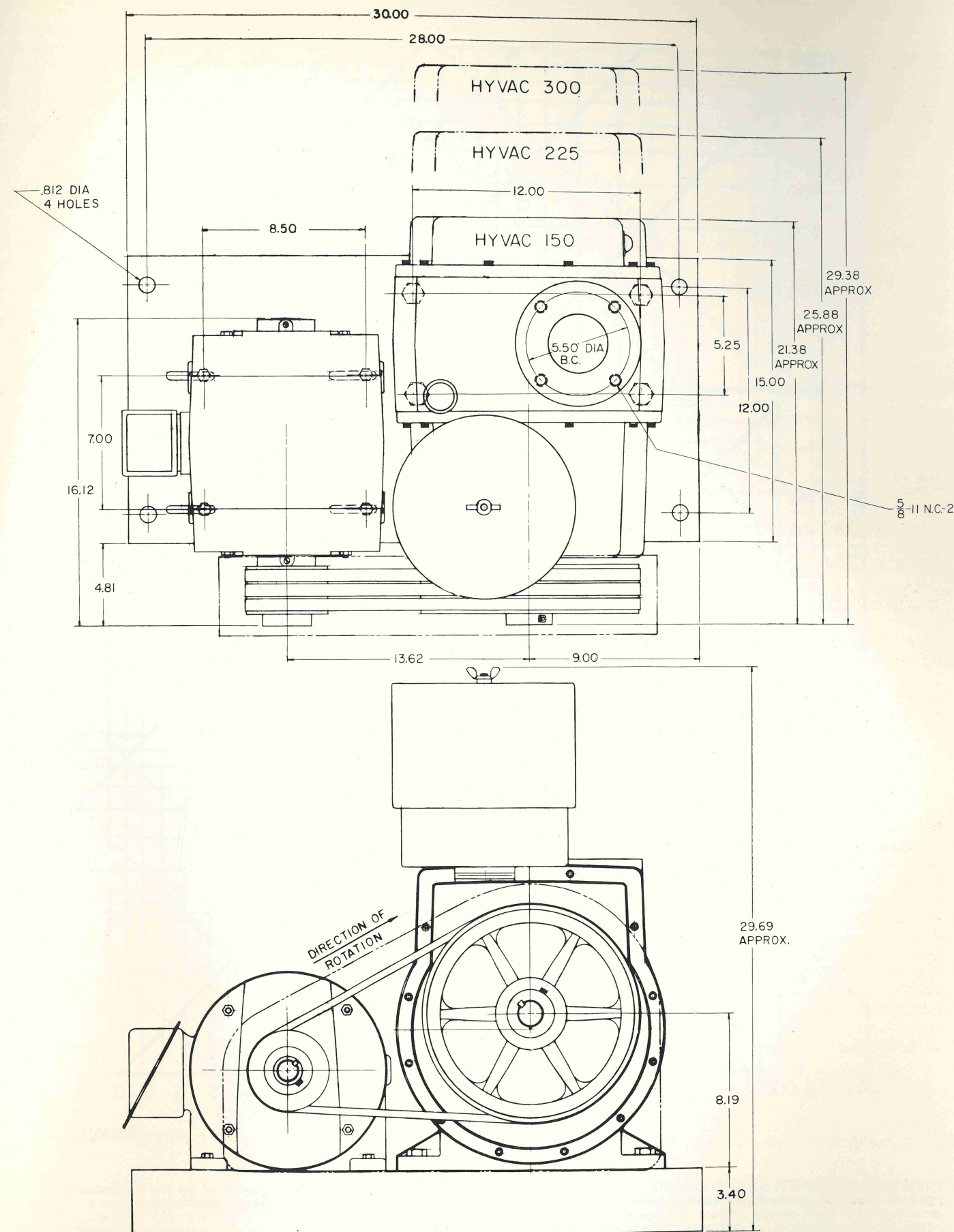
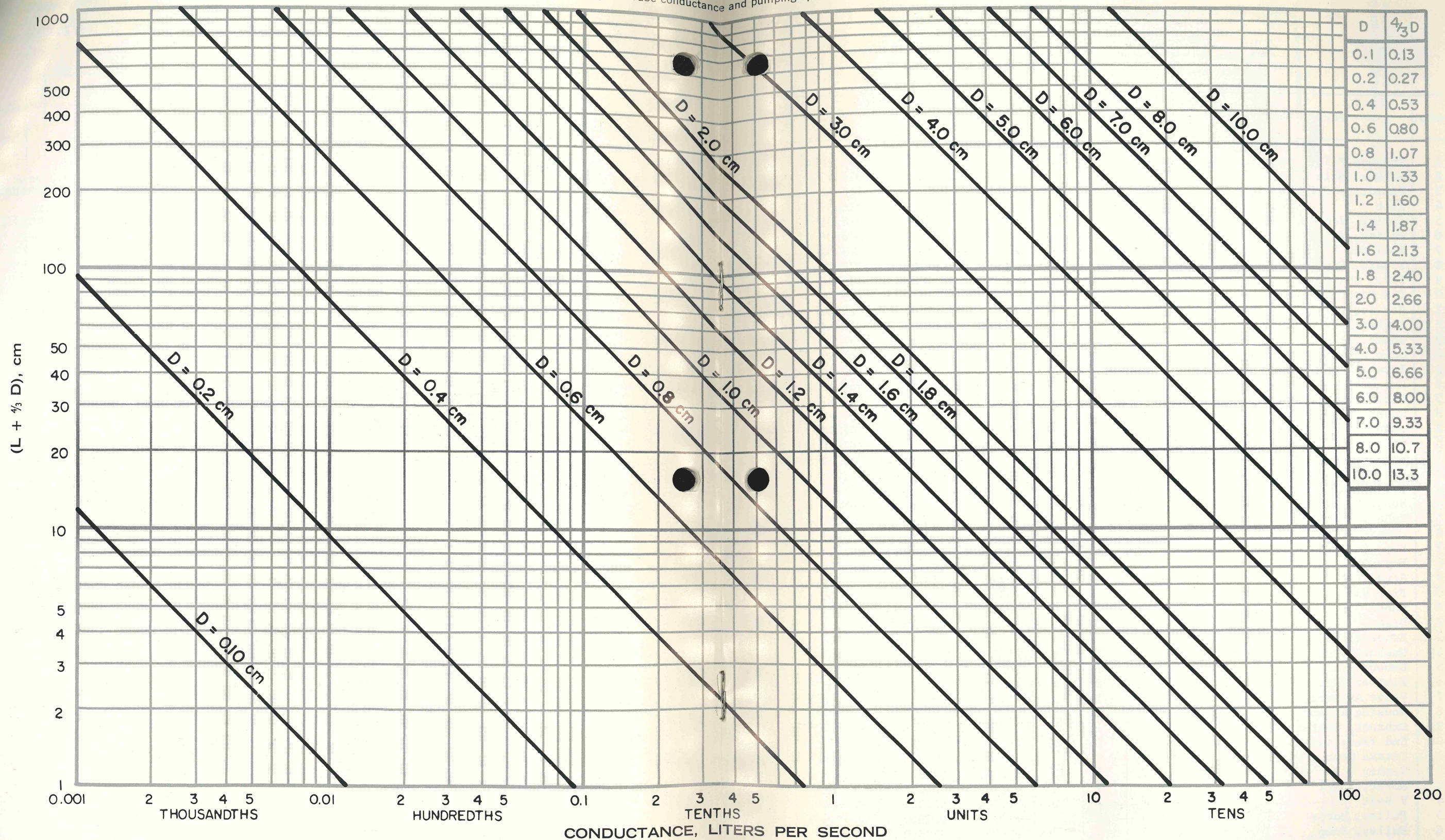


Fig. 3—Essential dimensions of the Hyvac 150, 225, and 300 pumps

Fig. 4—Tube conductance and pumping speed



TUBE CONDUCTANCE AND PUMPING SPEED. At pressures of a few microns and lower, the connection between the pump and the vacuum system may greatly reduce the speed of evacuation. Frequently, the "conductance" of the connecting tubes has greater influence on pumping speed than the speed of the pump. To obtain a pumping speed (S) as large as possible, the tube conductance (Z) must be very large when compared with the speed of the pump (S_1). This is clearly shown by the relation:

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{Z}$$

$$S = \frac{Z}{S_1 + Z} S_1$$

Since at best S is only a fraction of S_1 , the conductance of the connecting tubes should be as large as possible.

To aid in the proper selection of tubes, the accompanying family of curves has been constructed using semi-empirical equations originally derived by Knudsen¹. The conductance (Z), shown in liters/sec., is plotted as abscissas against the quantity $(L + \frac{4}{3} D)$ in cm, as ordinates. In addition to the parameter D , the value of $\frac{4}{3} D$ is shown on the table in the right hand corner of the graph, which facilitates the determination of the ordinate for a particular tube.

For example, suppose the conductance of a tube 50 cm long, having a diameter of 2 cm, is required. As it can be seen from the table, for $D = 2$, the value of $\frac{4}{3} D = 2.66$ cm. Referring to the curve, for $D = 2$ the conductance corresponding to the ordinate equal to $50 + 2.66$, (length plus $\frac{4}{3}$ the diameter) is about 1750 cc/sec.

Since the curves are parallel lines spaced logarithmically, conductance of tubes having diameters other than those given on the graph may be determined by properly placing lines on the chart parallel to those already shown.

When tubes of different size are connected in series to form a connection, the resultant conductance is computed after the fashion of electrical conductance, namely $\frac{1}{Z} = \frac{1}{b_1} + \frac{1}{b_2} + \dots + \frac{1}{b_n}$ where Z is the resultant conductance of tubes having individual conductances, b_1, b_2 , etc.

¹Knudsen, Ann. D. Phys. 28, pp 75-130, 1909.

Table IV
REPLACEMENT PARTS

Symbol	Part Name	Quantity Required			Part Number		
		Hyvac 150	Hyvac 225	Hyvac 300	Hyvac 150	Hyvac 225	Hyvac 300
1	Exhaust Filter Dome	1	1	1	093126-4	093126-4	093126-4
2	Hi-Seal Male Elbow	1	1	1	P16141	P16141	P16141
3	Direction Plate	1	1	1	P25363	P25365	P25366
4	Knob	1	1	1	P26081	P26081	P26081
5	Spring, Vane	4	6	6	P28105	P28105	P28105
6	Spring, Valve	4	4	4	P28106	P28106	P28106
7	Roll Pin	4	4	4	P29283	P29283	P29283
8	Truarc Ring	3	3	3	P29532	P29532	P29532
9	Seal, Shaft	1	1	1	P29538	P29538	P29538
10	Cap Screw, 1/2-13 x 6-1/2	6	12	6	P29545	P29545	P29545
11	Cap Screw, 1/2-13 x 10	-	-	6	---	---	P29547
12	Gasket	2	2	2	P35846	P35846	P35846
13	Shaft	1	1	1	P61238	P61239	P61240
14	Main Body	1	1	1	P61242	P61242	P61242
15	Intake Stator	-	1	1	---	P61243	P61244
16	Exhaust Stator	1	1	1	P61245	P61245	P61245
17	Rotor, 3-1/2 inches	1	2	1	P61247	P61247	P61247
18	Rotor, 7 inches	1	1	2	P61248	P61248	P61248
19	Vane, 3-1/2 inches	2	4	2	P61249	P61249	P61249
20	Vane, 7 inches	2	2	4	P61250	P61250	P61250
21	Exhaust End Cap	1	1	1	P61251	P61251	P61251
22	Intake End Cap	1	1	1	P61252	P61252	P61252
23	Valve, Flapper	2	2	2	P61253	P61253	P61253
24	Housing, Exhaust Valve	1	1	1	P61256	P61256	P61256
25	Exhaust Valve	1	1	1	P61257	P61257	P61257
26	Housing, Shaft Seal	1	1	1	P61261	P61261	P61261
27	Key, Shaft, 1/4 x 1/4 inch	4	6	6	P61262	P61262	P61262
28	Key, Shaft 5/16 x 5/16 inch	1	1	1	P61263	P61263	P61263
29	Stud, Valve	4	4	4	P63779	P63779	P63779
30	Pin, Vane	4	6	6	P63780	P63780	P63780
31	Tube	1	1	1	P63781	P63781	P63781
32	Disk	1	1	1	P65646	P65646	P65646
33	Bracket, Valve	2	2	2	P65862	P65862	P65862
34	Washer, Thrust	2	2	2	P65863	P65863	P65863
35	Exhaust Valve Stop	1	2	1	P65864	P65864	P65864
36	Flutter Valve	2	2	2	P65865	P65865	P65865
37	Valve Assembly	1	1	1	P67738	P67738	P67738
38	Housing Assembly	1	1	1	P67739	P67748	P67749
39	Exhaust, Center Plate Assembly	1	1	1	P67740	P67740	P67740
40	End Plate Assembly	2	2	2	P67741	P67741	P67741
41	Intake Center Plate Assembly	-	1	1	---	P67742	P67742
42	Washer	12	12	12	P78037	P78037	P78037
43	Motor, 3 HP	1	1	1	P24205	P24205	P24205
44	V Belt	3	3	3	P27204	P27204	P27204
45	Pulley, Motor	1	1	1	P29549	P29549	P29549
46	Pulley, Pump	1	1	1	P29550	P29550	P29550
47	Bushing	1	1	1	P29551	P29551	P29551
48	Bushing	1	1	1	P29552	P29552	P29552
49	Base, Pump	1	1	1	P61287	P61300	P61300
50	Belt Guard	1	1	1	P67750	P67750	P67750
51	Light Hyvac Oil, 5 Gallons	1	1	1	093050-4	093050-4	093050-4
52	Light Hyvac Oil, 1 Gallon	-	1	2	---	093050-3	093050-3
53	Unmounted Pump	1	1	1	P91957	P91959	P91960

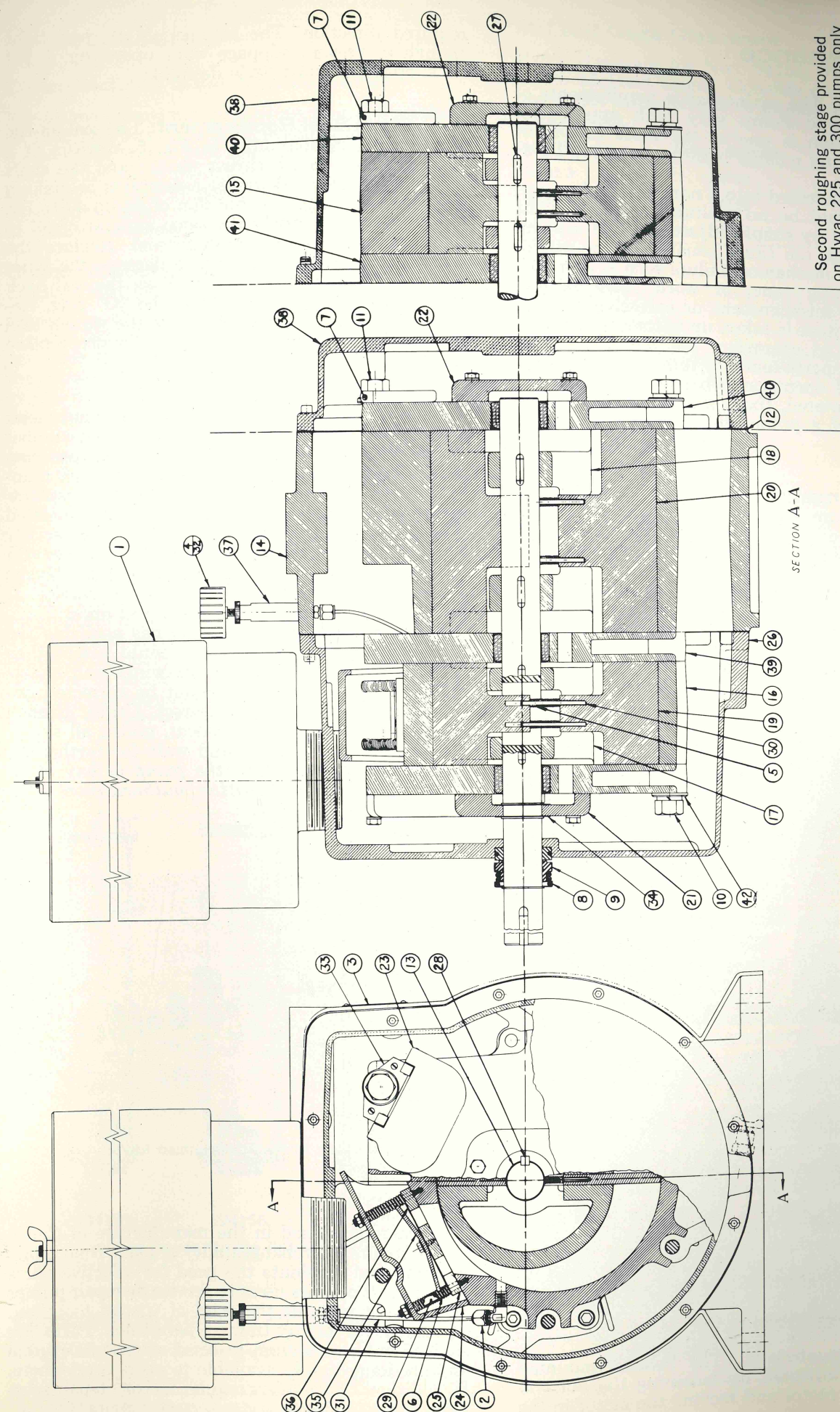


Fig. 5—Sectional view of the Hyvac 150, 225, and 300 pumps

7 maintenance

7.1 General: The maintenance requirements of the Cenco Hyvac Pump vary with application. Proper lubrication is one of the most important factors in securing reliable performance (See Paragraph 7.2). If a pump is connected into a normal leak-free system, there should be no malfunction that might not be remedied by simple adjustments. If a pump fails to function, the cause usually can be attributed to a minor mechanical failure such as a broken spring, a sticking vane, or worn valve release, rather than to misalignment or excessive wearing of parts. Since wear is taken up automatically during the course of operation, the junction of the various moving parts tends to form a more perfect seal. In normal operation, where no corrosive vapors are encountered, there will be no decrease in the efficiency of a pump over a period of several years.

7.2 Oil Change: A decrease in the value of maximum vacuum attainable is usually an indication that the oil has become contaminated. Oil should be changed at the first sign of contamination. To remove the oil, stop the pump, place a large receptacle underneath the drain, and open the drain cock. Turn the shaft several revolutions to force out any remaining oil. Flush with clean Flushing Oil, No. 93060, at least once and then refill with new Hyvac Oil No. 93050.



Hovac Oil, Cenco Nos. 93050 and 93055, and Hyvac Flushing Oil, Cenco No. 93060

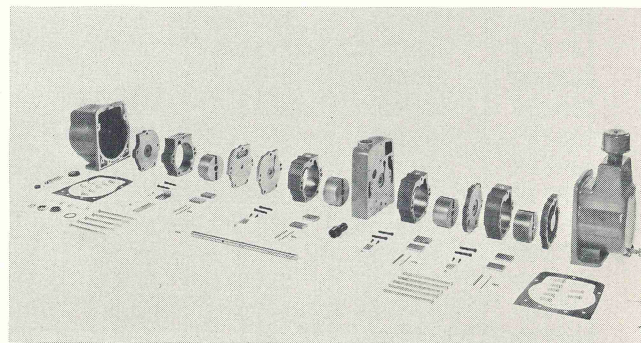
The frequency of oil change is dependent upon the use of the pump. An oil change may be needed only once in six months if the pump is operating against a vaporless and dustless system. Daily changes might be required if corrosive or highly condensable vapors enter the pump. When the pump is operated continuously, the oil temperature may reach 50° to 60°C. This temperature is normal for efficient operation of the pump.

7.3 Belt Adjustment: The belt in mounted pumps can be adjusted by loosening the bolts in the base of the motor and moving the motor in the

required direction. The belt should be just tight enough to prevent slippage while operating. A little slippage on starting is desirable.

7.4 Shaft Seal Replacement: The seal on the pump shaft, symbol (13) in Fig. 5, consists of a "Truarc" ring (8), a thrust washer and the shaft seal, in that order. Before re-assembling or making a replacement, apply a thin film of pump oil to the pump shaft. Also apply the same amount of oil to the inner surface of the shaft seal. Replace the shaft seal carefully so as not to damage the inner surface of the rubber seal ring. Push the seal back into the cavity until it contacts the "O" ring. Replace the thrust washer, and force the washer and spring over the groove in the shaft. Finally, replace the "Truarc" ring.

7.5 Repairs: Fig. 5 shows cross sectional views of the Hyvac Pump. Table IV lists the part number for each component of the pump. When ordering replacement parts, please give the exact part number. For repairs to the pump other than the replacement of the shaft seal, it is strongly recommended that the pump be returned to the factory, especially when adequate shop facilities are not available. If operated according to instructions, any Hyvac pump will provide years of satisfactory service. If trouble develops, turn off the pump at once. Only a qualified technician who has available the finest machine shop facilities should attempt to service the pump, using the drawings and charts provided. If the difficulty cannot be corrected immediately, contact your nearest Cenco Branch office or the Service Department, giving all symptoms of the malfunction and wait for further instructions. *Do not return the pump or any of its components without written authorization from Cenco.*



Typical Hyvac Pump disassembled for servicing

Easy Servicing

The techniques used in the manufacture of Cenco pumps assure interchangeability of parts from pump to pump and eliminate the need for selective parts fitting. This permits users to service or repair pumps on the spot without the need of special tools and equipment or highly-trained personnel. Parts are stocked in Cenco's coast-to-coast warehouse system and are immediately available to users everywhere. In addition, Cenco offers regular factory repair service at its main plant.

8 accessories

Cenco McLeod Gage, Double Range

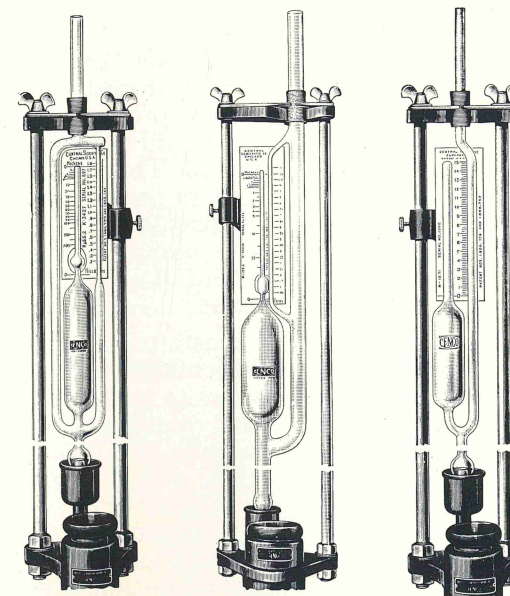
For all measurements of pressure from 0.5 millitorr to 1600 millitorr. One range reads in millitorr from 0.5 to about 200 or 250; the other to about 1.6 torr. Over-all height is 165 cm. The amount of mercury required is about 10 pounds. Weight, without mercury, 30 pounds.
No. 94151, without mercury

Cenco McLeod Gage, Improved Design Double Range

Similar to the No. 94151 but for pressures from about 0.005 to 1000 millitorr. Double range, with one scale reading to approximately 25 millitorr and the other to approximately 1000 millitorr. This gage is intended for use in a system being exhausted by means of a diffusion or a molecular pump. It is made with replaceable precision-bore tubing. This gage requires about 30 pounds of mercury for operation. Over-all height is about 190 cm; weight, without mercury, is about 45 lbs.
No. 94156, without mercury

Cenco McLeod Gage, Single Range

Similar to No. 94151 McLeod Gage, but with single range from 0 to 15 torr, reading to 0.1 torr. Scale magnification by the McLeod principle is about 10. For accurate measurement of gas pressures in the filling of discharge tubes and in measurements of pressure in industrial processes. About 10 lbs. of mercury are required.
No. 94160, without mercury



94151 94156 94160

Cenco measuring heads for the 94151, 94156, and 94160 McLeod Gages.

Cenco Mercury for McLeod Gages

CP, ACS, Triple distilled quicksilver.

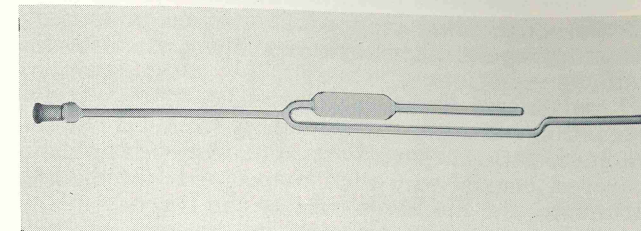
1 pound, bottle 5 pound, bottle

15 pounds maximum quantity for parcel post shipment.

McLeod Gage Glassware

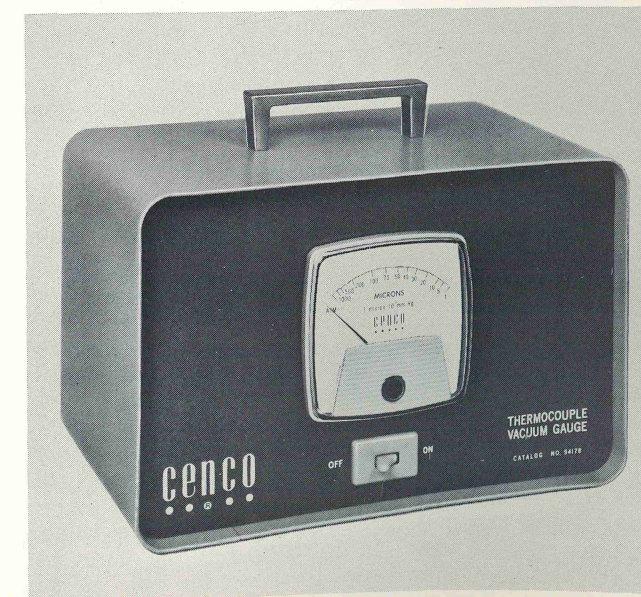
Extra glassware for Nos. 94151, 94156 and 94160 Cenco McLeod Gages. Consists of calibrated glass head with interchangeable ground joint and a calibrated scale.

Cenco No.	McLeod Gage No.	O.D. Connecting Tube
94165-3	94160	10 mm
94165-4	94156	18-19 mm
94165-5	94151	10 mm



Cenco Thermocouple Vacuum Gage

Measures pressures in the range of 1 to 1000 millitorr and reads directly on a single meter scale. Adjusted and calibrated for immediate use, this lightweight gage responds to both condensable and non-condensable gases. The all-metal thermocouple tube resists contamination, physical shock and may be operated at atmospheric pressure. The gage tube has a standard 1/8" NPT male thread, is 5 1/4" long and 1" in diameter. A 5-foot, plastic covered, 4-wire cable with octal socket is supplied for connecting the thermocouple tube to the Thermocouple Gage supply. A separate meter is not required for the heater current. A constant voltage transformer accommodates line voltage variations. The unit is 10 1/4" long, 6 1/2" high and 5 1/2" deep. Attractively finished in blue and beige enamel. Available for operation from either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Supplied with a 3-wire cord and plug for positive electrical connections. Shipping weight is 12 pounds.
No. 94178-1, 115 volt, 60 cycle, ac
No. 94178-8, 230 volt, 50 cycle, ac



Cenco Discharge Gage

Continuous and direct pressure readings from all condensable vapors and permanent gases present in a vacuum system are indicated on a single meter scale. Measures vacuum continuously from 0.001 millitorr to 20 millitorr. The calibration is standardized with a McLeod Gage using dry air. The Discharge Vacuum Gage includes a transistorized dc amplifier and relay to operate auxiliary equipment such as pumps, heaters, etc., at any desired pressure on the scale. Both normally-open and normally-closed contacts are provided through banana jacks on the front panel, permitting the apparatus to be started and stopped at a given pressure. A built-in regulating transformer accommodates line voltage variations.

The open end of the discharge tube, 1" OD, is connected into the vacuum system by means of suitable vacuum fittings, gage ports, etc. A 6-foot, plastic-covered, coaxial wire with connector is supplied for attaching the discharge tube to the Discharge Vacuum Gage.



The Discharge Gage is 16 1/4" long, 7 1/2" high and 6 3/4" deep. Attractively finished in blue and beige enamel. Available for either 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. Relay contacts are rated for 1 ampere. For heavier loads, a No. 99720-1 or 99725 relay may be used. Supplied with a 3-wire line cord and plug for ground connections. Shipping weight is 15 pounds.

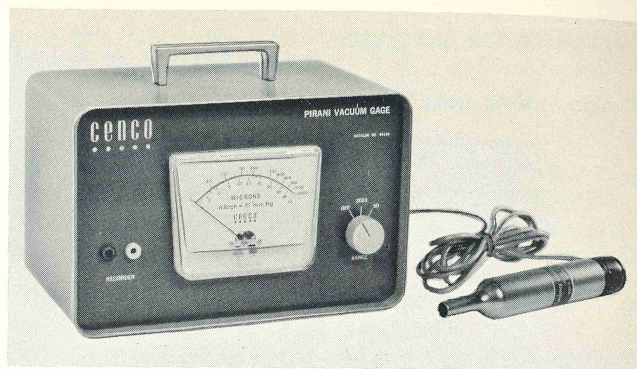
No. 94183-1, 115 volt, 60 cycle, ac
No. 94183-8, 230 volt, 50 cycle, ac

Discharge Tube

A cold-cathode glow-discharge type for replacement in No. 94183 Discharge Gage.
No. 94187

Cenco Pirani Gage

The Cenco Pirani Vacuum Gage, a thermal conductivity type, is based on the temperature and/or resistance change of a heated filament. This change or unbalance is measured on a conventional wheatstone bridge circuit. One arm of the bridge utilizes a compensating tube, sealed under vacuum, to make the circuit insensitive to ambient temperature changes. Pressure is continuously read on a meter having two scales calibrated to the bridge unbalance. One range is 0 to 50 x 10⁻³ torr, and the other is 50 x 10⁻³ torr to 2 torr. The power supply is a full wave bridge rectifier using a constant voltage source. This makes the instrument very stable. Two banana jacks are located on the front panel for recorder use.



Zero drift, which can be a serious problem in Pirani Gages, has been corrected to a great extent by operation of a filament at a much lower temperature (a maximum of 250° C. at a pressure well below 1.0 millitorr) and by inorganic treatment of the filament to provide a stable, inorganic, black surface. The Pirani tube is 7" long with an envelope OD of 1 1/4" and a tubulation OD of 1/2". The Cenco Pirani Vacuum Gage is 10 1/4" long, 6 1/2" high, and 5 1/2" deep. Attractively finished in blue and beige enamel, it is available for 115 volt, 60 cycle, ac or 230 volt, 50 cycle, ac. The power consumption is 12 watts. Net weight is 8 pounds.

No. 94190-1, 115 volt, 60 cycle
No. 94190-8, 230 volt, 50 cycle

Cenco Ionization Gage

This excellent Ionization Gage incorporates a wide range electrometer amplifier and is designed for use with Bayard-Alpert inverted ionization gage tubes. With it, dry air pressure measurements can be made in the range from 1 x 10⁻³ to 2 x 10⁻¹⁰ torr.

Circuitry

Six separate circuits are used in the Cenco Ionization Gage: a power supply, an electrometer type ion current amplifier, an over-pressure protective circuit, an emission current regulator, a grid outgassing circuit and a recorder output circuit. The amplifier has near 100% negative feedback to provide excellent stability in reading the ion currents from the gage tube collector. The protective circuit controls the filament circuit and, in the event of an overpressure condition, turns the filament off.

The emission regulator is a constant current device with a wide range of adjustments permitting gage tubes with different sensitivities to be used without the need for time-consuming recalibration of the amplifier. The regulator corrects for line voltage fluctuations, pressure changes, and emitter work function changes. The grid outgas circuit supplies current to the grid of the ionization gage tube to bring the grid to a bright red heat for outgassing of the gage tube walls. The recorder output is variable between 0 and 10 millivolts for full scale reading of the pressure meter.



Simplified Control Panel

Controls are grouped for easy reading and use. The pressure gage is calibrated in 100 divisions from 0 to 10. A six decade range switch can be set for readings from 10⁻³ to 10⁻¹⁰. Filament-on-and-off switches have built-in pilot lamps. The outgas circuit switch and emission gage are also mounted on the front panel.

Controller Model

The No. 94198 is provided with a SPDT, 3-ampere, contact meter relay that can be set to turn auxiliary equipment on or off at any pre-set pressure within the range of the gage. A setting control is provided on the front panel.



Specifications

OPERATING RANGE, torr	1 x 10 ⁻³ to 2 x 10 ⁻¹⁰
ZERO DRIFT, % of full scale	2
OVERPRESSURE CIRCUIT, % of full scale	125
OPERATING VOLTAGE	115, 60 cycle
WATTAGE	
Operating	67
Outgassing	110

Gages are supplied with a 3-wire line cord and plug for connection to a power line, a 4-wire gage power cable, and a coaxial cable for ion collection.

No. 94197 without controller
No. 94198 with controller

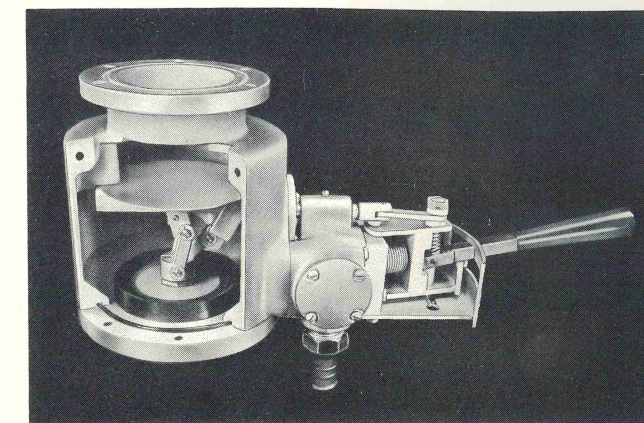
Ionization Gage Tubes

Hot filament tubes for use with the Nos. 94197 and 94198 Ionization Gages. All types utilize the Bayard-Alpert inverted element configuration and are suitable for measuring pressure in the range from 10⁻³ to 10⁻¹⁰ torr. The tubes are provided with three filaments that can be used separately or collectively to allow for both longer tube life and higher gage sensitivity when using higher electron currents to the grid. Tube sensitivity is 60 microamperes per micron when using 5 milliamperes grid current or 100 microamperes when using 8 1/2 ma grid current. Four types are available, three with tubulation enclosed filaments and one with filaments exposed for extremely accurate readings. Connections are provided to outgas the grid structure by passing current through the grid element.

No. 94195-1 With 3/4-inch Nonex tubulation
No. 94195-2 With 3/4-inch Pyrex tubulation
No. 94195-3 With 3/4-inch Kovar tubulation
No. 94196 Without tubulation

Cenco Three-Way Vacuum Valve

Designed to serve as a master control in high vacuum systems employing a diffusion pump and a mechanical pump. It replaces the roughing, foreline and high-vacuum valves now being used in conventional systems. With this valve, the evacuated chamber may be quickly isolated from and connected back into the pumping system without shutting down the pumps. Rapid single lever action facilitates positive mechanical switching to each of three operating positions: "Closed," "Rough Down," and "Diffusion Pump." This direct mechanical movement eliminates problems associated with solenoid operated and hydraulic or pneumatic mechanisms. A water-cooled baffle is included to minimize backstreaming from the diffusion pump. The control lever extends 6" beyond the detent mechanism to provide convenient operation when the valve is mounted beneath a large baseplate or behind a panel.



Flow Passages. All passages provide full pipe area throughout. Throat openings for the main valve are 4 inches in diameter. Passages for the foreline and roughing line are equivalent to 1 inch pipe.

Outgassing. Minimum outgassing time is required as only materials with low-vapor pressure are used for seals. Special attention has also been given in construction to eliminate "virtual leaks."

Vacuum Tightness. The valve body and end plates are cast of close grained aluminum and vacuum impregnated after machining to assure tightness. Metallic bellows are used to seal the two movable links and rubber rings are employed at the fixed joints. The three valve disks consist of metal plates with integrally molded rubber sealing lips.

Connections. Six 1 3/32" diameter holes equally spaced on 5 1/4" diameter bolt circle are provided to attach the valve to a pump plate. To connect a diffusion pump, six 3/8-24 UNF x 1/2" deep holes equally spaced on 5 1/4" diameter bolt circle are provided. Foreline and roughing lines are connected on two nipples for 1" I.D. rubber hose. Connect 90° elbow nipple to diffusion pump outlet and straight nipple to mechanical pump. To connect the water lines, rubber tubing or ordinary 3/8" diameter copper tubing with compression type fittings may be used. The valve cooling coil may be connected in series (but in front of) the cooling coil on the diffusion pump or to an individual water source. Shipping weight is 35 lbs.
No. 94552

Cenco Liquid Nitrogen Traps

For use in vacuum systems to condense moisture and oil vapors without materially retarding system conductance. The traps consist basically of two concentric metal tubes, top and bottom plates, a vacuum cap and inlet nipple. The bottom plate has a Teflon O-ring seal to permit periodic draining of the condensate to the collector tube. From here, condensate can be emptied simply by removing the threaded cap at the bottom of the trap. In operation, the syphon tube is connected to a vacuum pump and the collection tube to the system being evacuated. Connections can be made with either rubber tubing or with metal tubing for permanent installations. A Dewar-type flask with a suitable coolant such as liquid nitrogen or dry-ice-alcohol is required to condense the vapors in the collector tube. Cenco No. 15830-4 Dewar Flask is recommended for all sizes of traps. The traps are available in a choice of welded aluminum or silver-soldered stainless steel. All types have an overall length of 12 inches and an effective trap length of 7½ inches.

Cenco No.	Syphon Tube and Intake Nipple O.D.	Collector Tube O.D.	Cenco No.	Syphon Tube and Intake Nipple O.D.	Collector Tube O.D.
Aluminum			Stainless Stl.		
94009-1	1"*	2"	94009-4	1"*	2"
94009-2	1¼"***	2¼"	94009-5	1¼"***	2¼"
94009-3	1¾"***	3"	94009-6	1¾"***	3"

*For ¾" water tubing, ⅞" mechanical tubing or 1" rubber tubing.
 **For 1" water tubing, 1½" mechanical tubing or 1¼" rubber tubing.
 ***For 1½" water tubing, 1⅝" mechanical tubing or 1¾" rubber tubing.

Exhaust Filters

Easy to install and long lasting, these filters trap oil vapors and oil droplets which may be exhausted from mechanical pumps. The filter consists of several layers of a non-organic fiber. Oil which is separated from the air at the pump exhaust port is drained back into the pump. Available in four sizes to fit most Cenco Vacuum Pumps.

Cenco No.	Inlet Connection	Capacity CFM	For Use with
93126-1	½" IPS	5	Hyvac 2* Hyvac 7 (Single or Two-Stage) Megavac
93126-2	¾" IPS	10	Hyvac 14 (Single or Two-Stage)
93126-3	1½" IPS	20	Hyvac 28 (Two-Stage only) Hyvac 45
93126-4	3" IPS	100	Hyvac 150, 225, 300

*Requires No. 93122 Adapter



Filter Elements

Replaceable filter elements for the No. 93126 Exhaust Filters listed above.

Cat. No.	Fits Filter No.	Cat. No.	Fits Filter No.
93127-1	93126-1	93127-3	93126-3
93127-2	93126-2	93127-4	93126-4

Light Grade, Cenco-Hyvac Vacuum Pump Oil

The development of Cenco-Hyvac Oil is the result of exhaustive tests made in the Cenco laboratories. The oil incorporates two essential high vacuum characteristics: A low vapor pressure which does not materially increase at temperatures up to 50° C., and a viscosity sufficiently low for use at 15° C. that remains fairly constant up to 50° C. This oil should always be used to achieve the guaranteed performance of Cenco oil-sealed pumps.

Cenco No.	Size	Case Quantity
93050-2	1 quart	12
93050-3	1 gallon	6
93050-4	5 gallons	6

Sylphon Packless High Vacuum Valve

With special seat for use in high vacuum systems where part of the system must be occasionally exposed to the atmosphere. A "Teflon" disk valve with stem enclosed in metallic sylphon-type bellows prevents the entrance of air through the valve stem bushings. Connections are made with standard pipe of appropriate size.

Cenco No.	Connection Size	Over-All Height	Length Between Connections
94551-1	1"	7⅞"	4¼"
94551-2	1½"	8¼"	4⅝"

Low Pressure Solenoid Valve

For use on the intake port of Cenco Vacuum Pumps to automatically close off the evacuated system when the motor is stopped. The bodies are of aluminum finished in blue-gray hammertone, with stainless steel valve seat and armature pilot plunger. Valve diaphragm is of special synthetic rubber which withstands temperatures to 180°F. The rim of the diaphragm serves as a gasket, assuring correct alignment of assembly. Holding power consumption is 10 watts. Maximum operating range 15 lb./sq. in. Supplied with proper size close nipple to attach the valve to the pump intake after the regularly supplied nipple or coupling has been removed. No. 93062 Vacuum Sealing Compound should be used to seal the threads at the pump connection and the nipple or the coupling at the top of the valve. Nine sizes are available. Size 1 for Hyvac 2 Pumps; Sizes 2 and 3 for Hyvac 7, Pressovac, and Megavac Pumps; Sizes 4 and 5 for Hyvac 14, Hypervac 23 and Hypervac 25 Pumps; Sizes 6 and 7 for Hyvac 28 Pumps; Sizes 10 and 11 for Hyvac 45 Pumps.

IPS Thread, Inches				IPS Thread, Inches			
Cenco No.	Volts	Cycles		Cenco No.	Volts	Cycles	
94280-1	115	50/60	⅜	94280-6	115	60	1
94280-2	115	50/60	½	94280-7	230	60	1
94280-3	230	50/60	½	94280-10	115	60	1½
94280-4	115	50/60	¾	94280-11	230	60	1½
94280-5	230	50/60	¾				

Extra Heavy Wall, Red Tubing, Cenco

For filter and vacuum pump connections, mercury leveling bulbs, etc. Made to our special formula for high-vacuum work. Sold in minimum lengths of 5 feet in sizes 1 to 3 and 1 foot in sizes 6 to 11.

No. 18204	1	2	3	6	8	11
Dash No.						
ID, inch	⅛	⅜	¼	⅜	⅝	1⅜
Wall thickness, inch	⅜	⅜	⅜	⅜	⅜	⅜

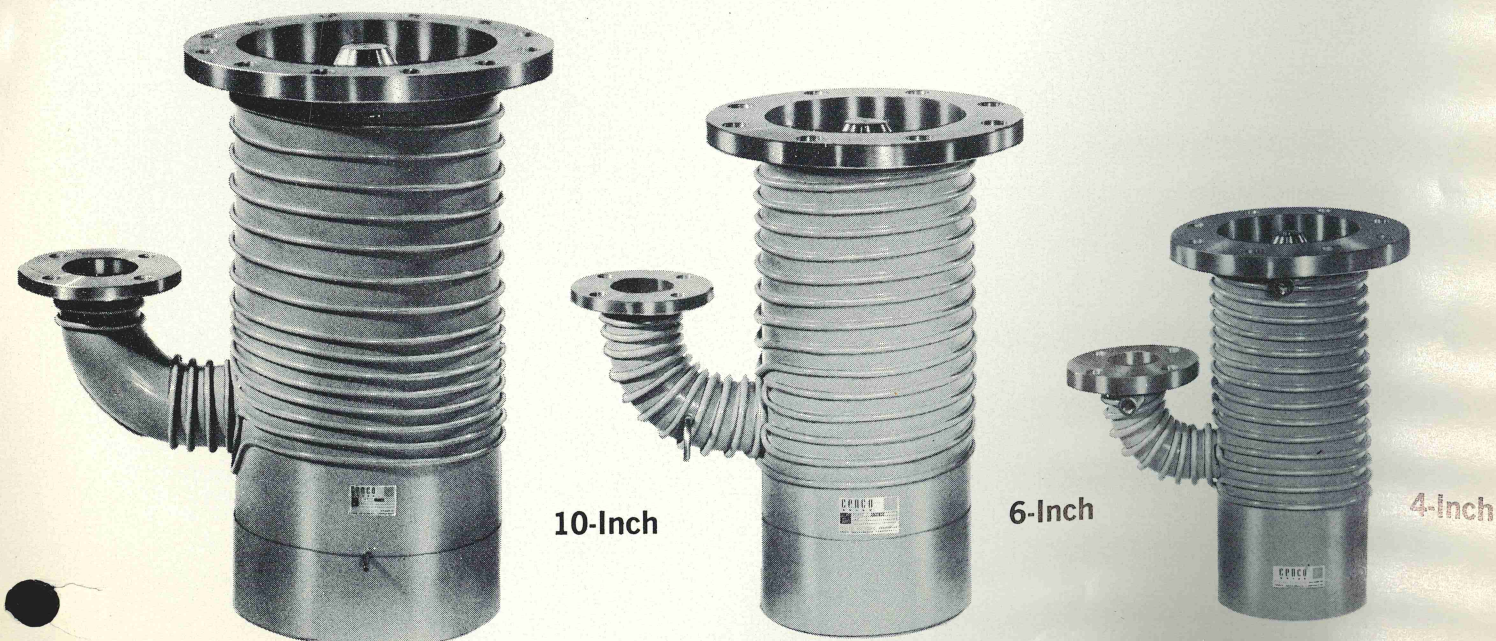
Cenco High-Speed Diffusion Pumps

Operating Specifications	4-Inch Pump	6-Inch Pump	10-Inch Pump
MAXIMUM PUMPING SPEED, liters per second	1000	2000	4500
OPERATING PRESSURE, torr (mm of Hg)	From 2 x 10 ⁻³ to less than 1 x 10 ⁻⁷		
LIMITING FOREPRESSURE, torr			
At full load	0.65	0.50	0.45
At no load	0.80	0.70	0.60
PUMP FLUID			
Recommended Cenco No.	93264	93264	93264
Quantity, cc	395	630	1815
COOLING WATER REQUIREMENTS, gallons per min. at 20°C	0.25	0.40	0.75
HEATER			
Voltage	115	115	230
Wattage	1200	1800	3600
FOREPUMP REQUIREMENTS, Cubic ft. per minute	5	10	25
RECOMMENDED FOREPUMP	HYVAC 14	HYVAC 28	HYVAC 150

Pumps are available with either stainless steel bodies and flanges for maximum service or with more moderately priced carbon steel bodies and flanges. Both stainless steel and carbon steel models are furnished complete as described with stainless steel jets but without pumping fluid, powerstat or forepump. For complete dimensional details and specifications, refer to the tables on this page.

Ordering Guide

Cenco No.	Pump Type	Size	Cenco No.	Pump Type	Size
93405	Stainless Steel	4-Inch	93411	Carbon Steel	6-Inch
93406	Carbon Steel	4-Inch	93415	Stainless Steel	10-Inch
93410	Stainless Steel	6-Inch	93416	Carbon Steel	10-Inch



9 bibliography

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* Research conducted in the vacuum laboratory of Central Scientific Company.